THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. CXIV. No. 2510.] LONDON, JUNE 20, 1911. [63RD YEAR. PRICE 6d.

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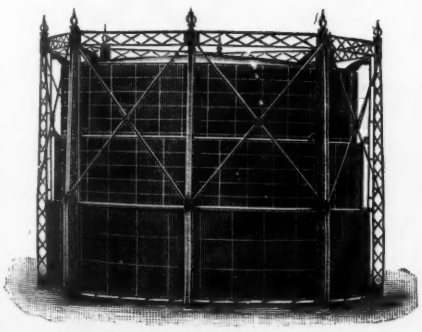

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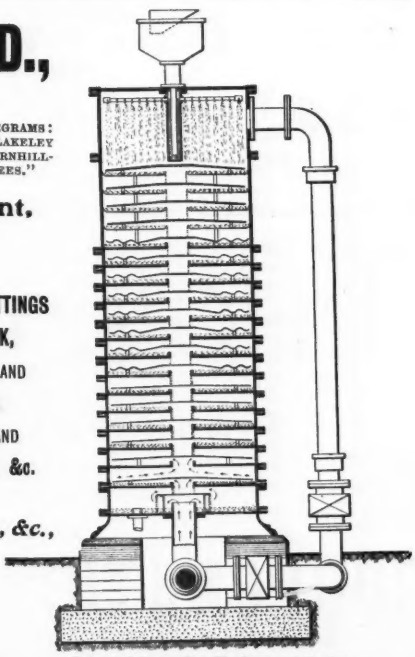

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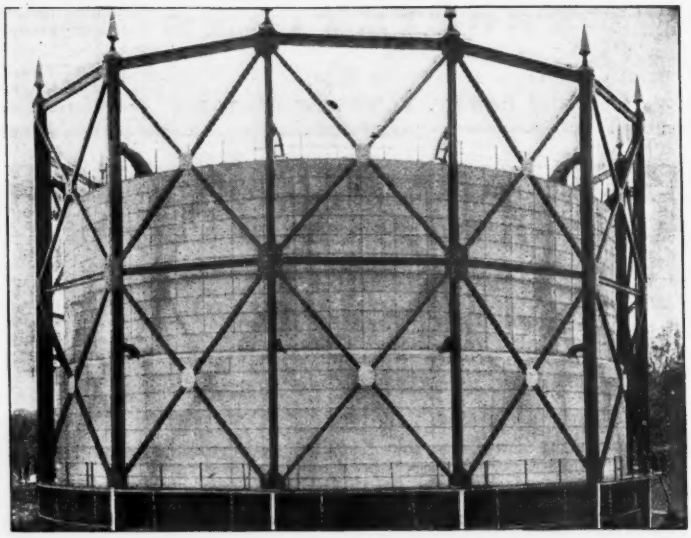

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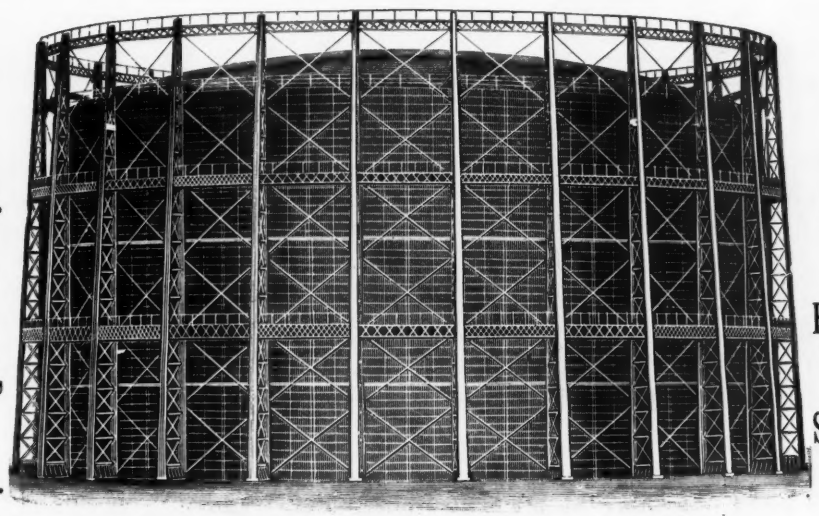

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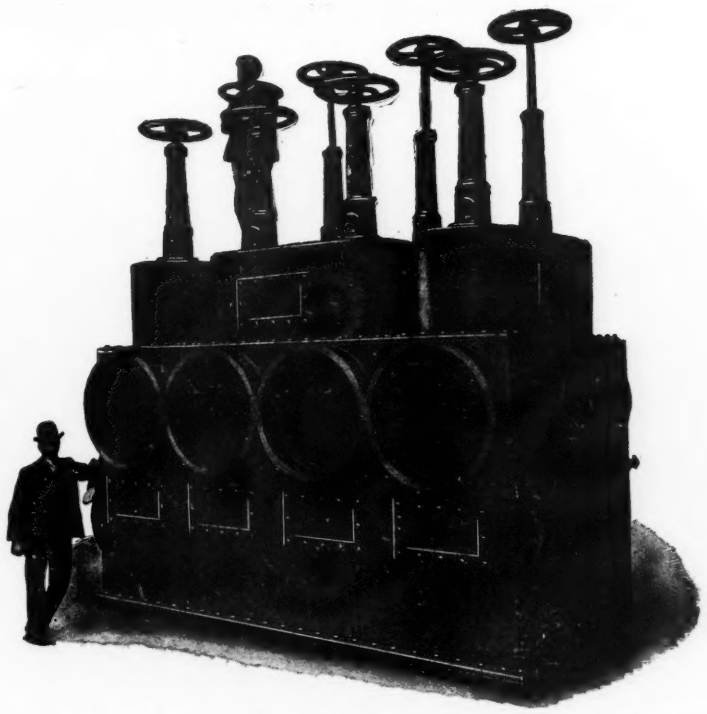

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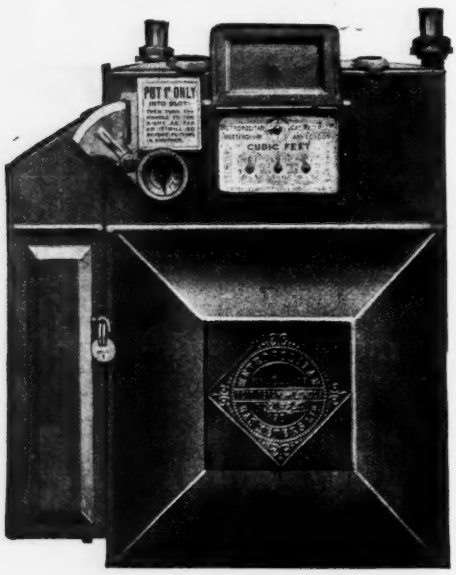

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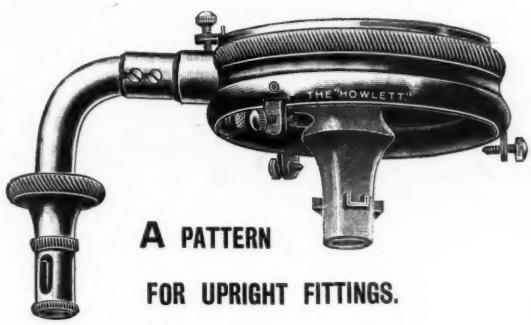


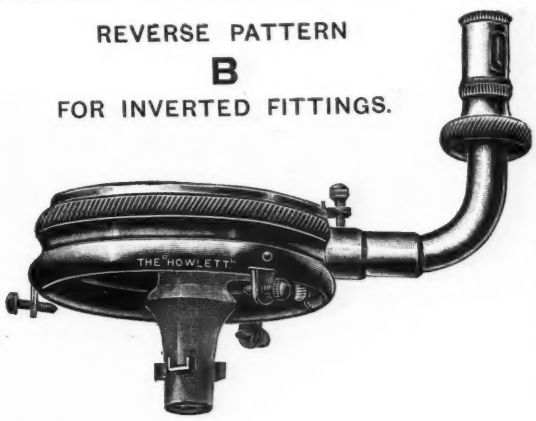
A PATTERN

FOR UPRIGHT FITTINGS.

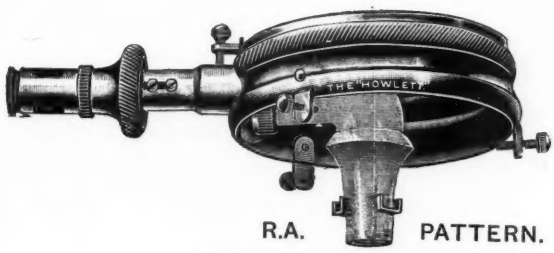
REVERSE PATTERN

B

FOR INVERTED FITTINGS.



NO BLACKENED FITTINGS. UNRIVALLED FOR CLEANLINESS.



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R.A. PATTERN.

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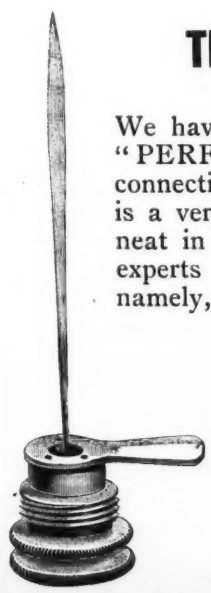

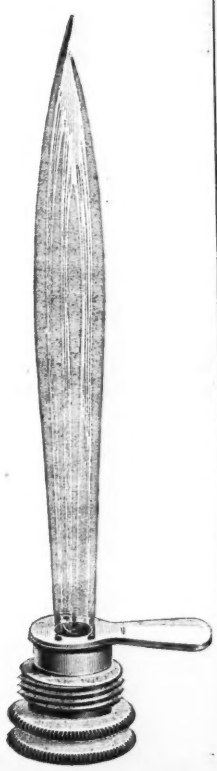

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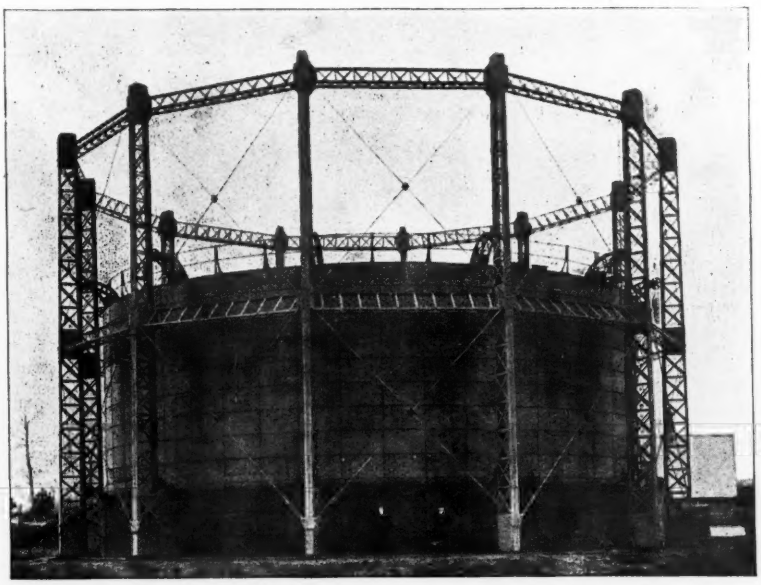

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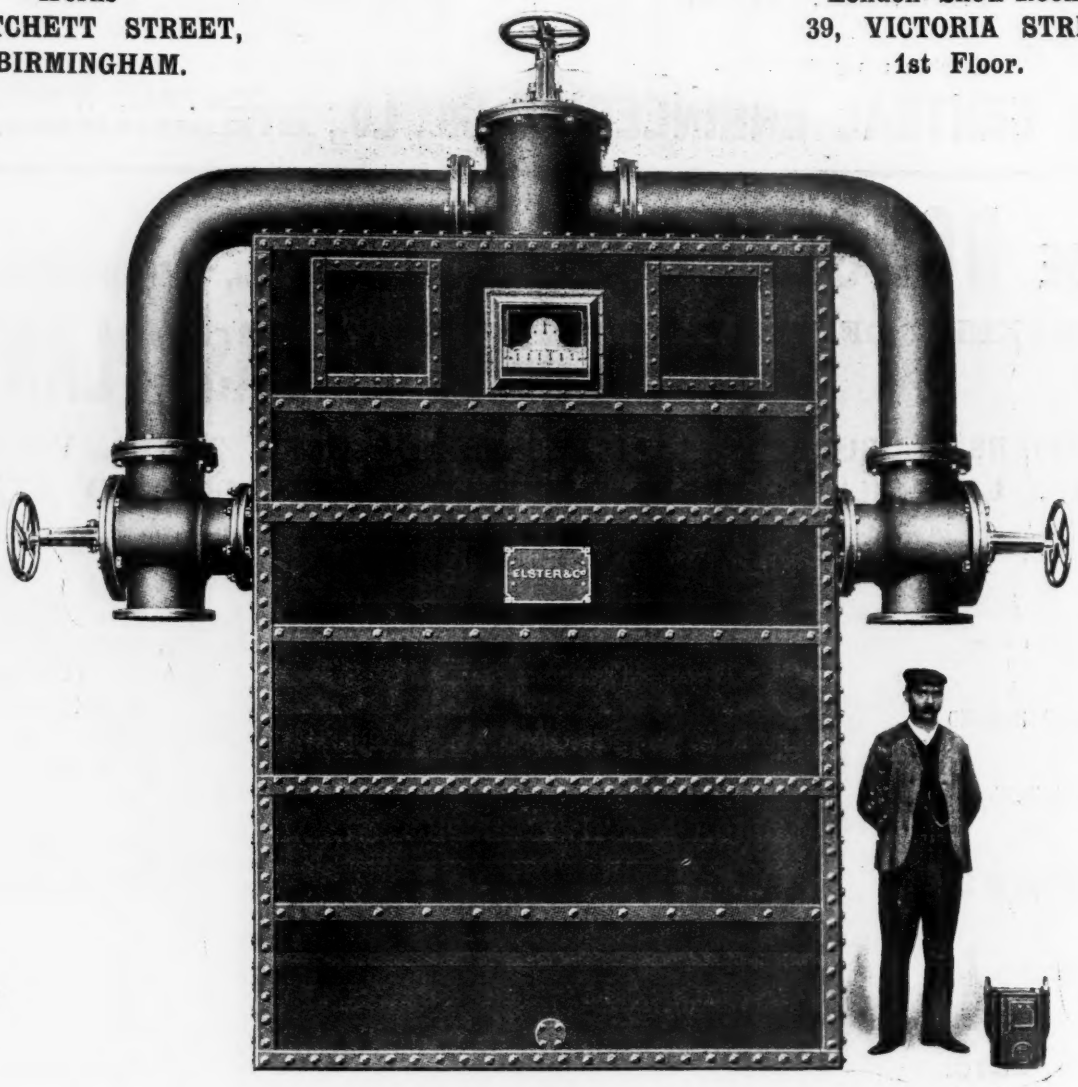

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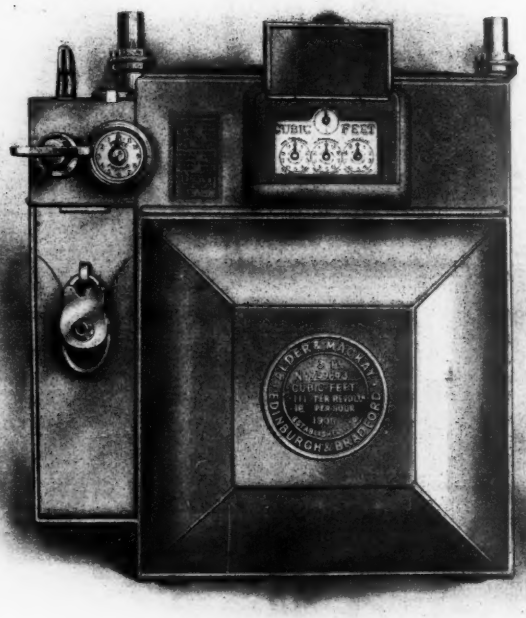

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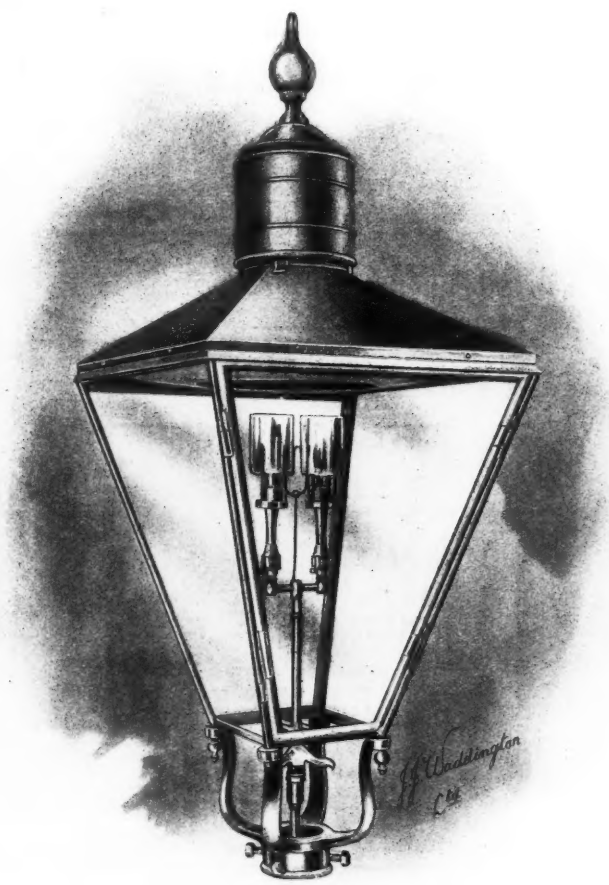

THE EDINBURGH LANTERN.

STANDARD HURRICANE-PROOF LANTERNS,

FOR SINGLE, DOUBLE, OR TRIPLE BURNERS.

THE ACME OF EFFICIENCY AND RELIABILITY.

FULL PARTICULARS FURNISHED ON APPLICATION.

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"NEW CENTURY" IMPROVED PATENT COIN PREPAYMENT GAS-METERS

FITTED WITH DETACHABLE ATTACHMENTS.

ARRANGED FOR 1d., 6d., 1s., OR ANY OTHER COIN DESIRED.

These Meters are giving Universal Satisfaction wherever adopted.

Guaranteed for Five Years.

Dry Meter in Tin-Plate Case, fitted with Attachment.

Price changed *in situ* by means of One Crown Wheel only.

COMPACT,

DURABLE,

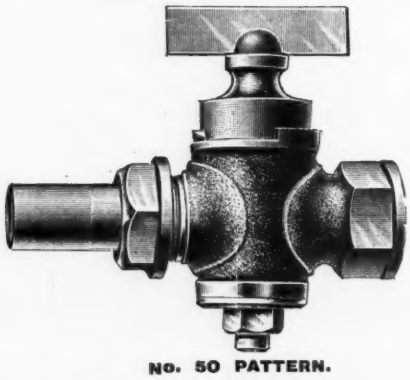
RELIABLE,

SIMPLE.

Wet Meter in Cast-Iron Case, with Attachment Removed.

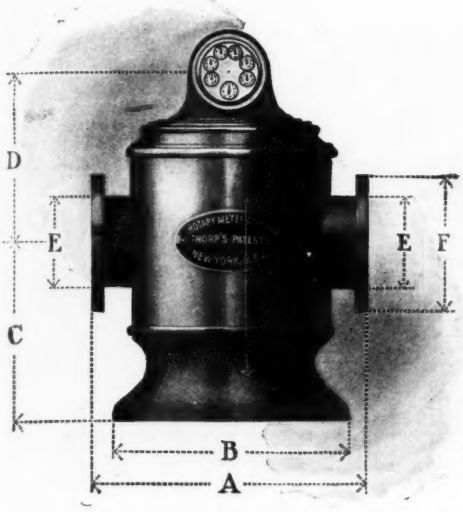
STRONG MAIN GAS COCKS, FERRULES, &c.,

ALSO STEAM AND WATER FITTINGS OF THE VERY BEST QUALITY AND WORKMANSHIP.



No. 50 PATTERN.

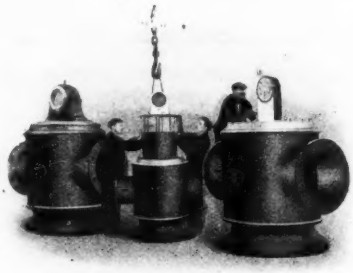
WE SOLICIT YOUR ENQUIRIES.



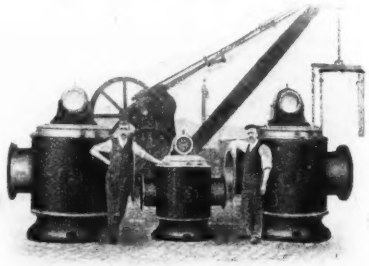
ROTARY STATION METER.
For Coal Gas, Water Gas, or mixed Coal and Water Gas.

SPECIAL METER.
For Coke Oven Gas, and Fuel Gas.

Two 60,000 cubic feet per hour and One 30,000 cubic feet per hour Meters.



Putting on the finishing touches.



Ready for shipment.

A WORLD'S RECORD

IN LARGE METERS.

Our English Works

ALONE

HAS SUPPLIED

Station Meters,

Having an Annual Capacity in Cubic Feet of over

102 THOUSAND MILLIONS

(102,000,000,000),

AND

The American Works

HAS SUPPLIED

Station Meters,

Having an Annual Capacity in Cubic Feet of over

122 THOUSAND MILLIONS

(122,000,000,000).

YOUR ORDERS OR ENQUIRIES SOLICITED.

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Telegrams—
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MANUFACTURERS OF

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To withstand abrasion, to radiate heat, or to take exceptional Fire.
The most modern Equipment.
Make impartial Tests and specify our Products.

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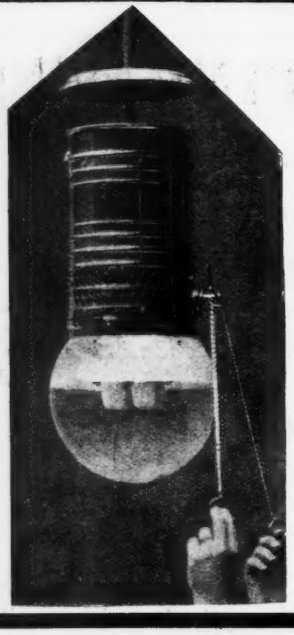

IS IT POSSIBLE

That over 1000 Gas Companies and Corporations would purchase our AMERICAN ARC LAMPS unless they were of great and

EXTRAORDINARY MERIT?

Entirely Unsolicited.

What a large Corporation is saying:

Aberdeen, April 4th, 1911.

"In the '**Block Arc**' you have an excellent lamp, and I have no doubt there is a good field for it in Aberdeen."

Yours faithfully,
(Signed) SAMUEL MILNE,
Gas Engineer, Aberdeen.

What a large User is saying:

Whitehaven, April 6th, 1911.

"The lamp is very satisfactory, and is quite a centre of admiration by customers."

Yours truly,
(Signed) J. NICHOLSON.

Space in this Journal is too valuable and costly, but we have hundreds of similar letters that we could quote.

THERE IS NOT A LAMP IN THE WIDE WORLD LIKE THIS AMERICAN ARC.

Gives 30 per cent. more usable light on 25 per cent. less gas consumption than any four-burner Gas Lamp.

IT PAYS FOR ITSELF IN GAS SAVING WITH BENEFIT OF GREATER EFFICIENCY.

To give you an opportunity of seeing this Lamp, we will readily supply one lamp upon a seven days' trial free of any charge to you.
You may fix it—test it—and use it. An Unprecedented Opportunity. WRITE US NOW.

BLOCK LIGHT CO., LTD., 54, Milk Street, MANCHESTER.

A 28-page Booklet dealing concisely with each important point of this lamp supplied on application.
Drop us a postcard and we will send you one.

Liberal Trading Discount Allowed to the Trade. **Obtainable from all Wholesale Merchants.**

BIRTLEY IRON CO.,

Established 1820,

Owners of the Birtley Iron Works and Pelaw Main Collieries,

GENERAL ENGINEERS AND IRONFOUNDERS.

Makers of Cast-Iron PIPES and CONNECTIONS for Gas, Water, Steam, and other purposes; also TANKS, COLUMNS of every description, Hydraulic, and Colliery PLANT, &c.

Illustrated Catalogue, giving complete list of our manufactures, on application.

Works & Offices: **BIRTLEY, CO. DURHAM.**

Telegrams: "BIRTLEY, NEWCASTLE-ON-TYNE."

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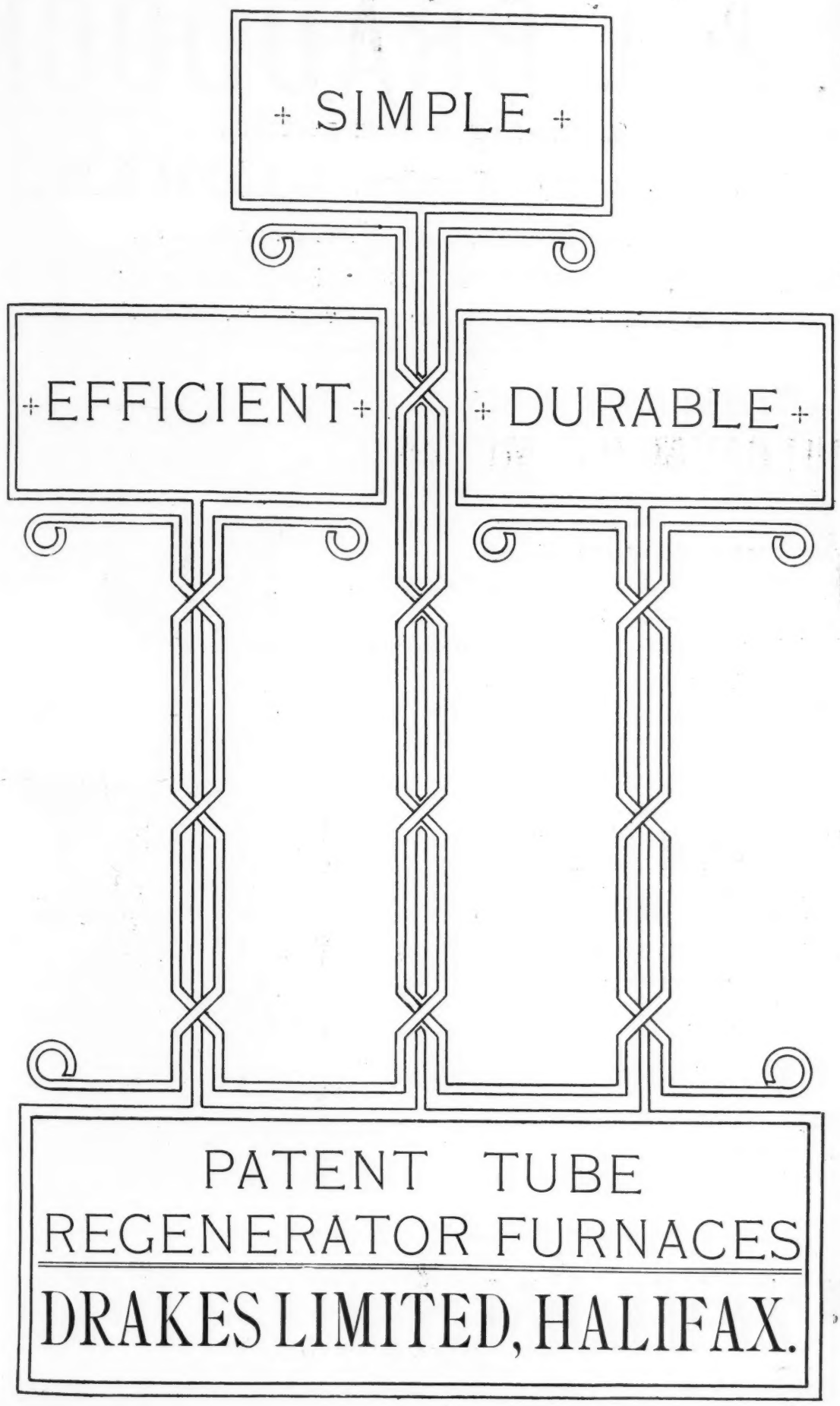
SIMPLE
EFFICIENT
DURABLE
PATENT TUBE
REGENERATOR FURNACES
DRAKES LIMITED, HALIFAX.

J. & J. BRADDOCK

(BRANCH OF METERS LIMITED),

Globe Meter Works, OLDHAM.

Telegrams: "BRADDOCK, OLDHAM." National Telephone No. 815.

AND 45 & 47, WESTMINSTER BRIDGE ROAD, LONDON, S.E.

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PREPAYMENT METERS.

WITH CHANGE WHEELS OR SELF-CONTAINED PRICE CHANGERS.

Absolutely Reliable. Positive in Action.
Very Extensively Used.
Strong and Quite "Up-to-date."

BRADDOCK'S PATENT

GAS STATION GOVERNORS

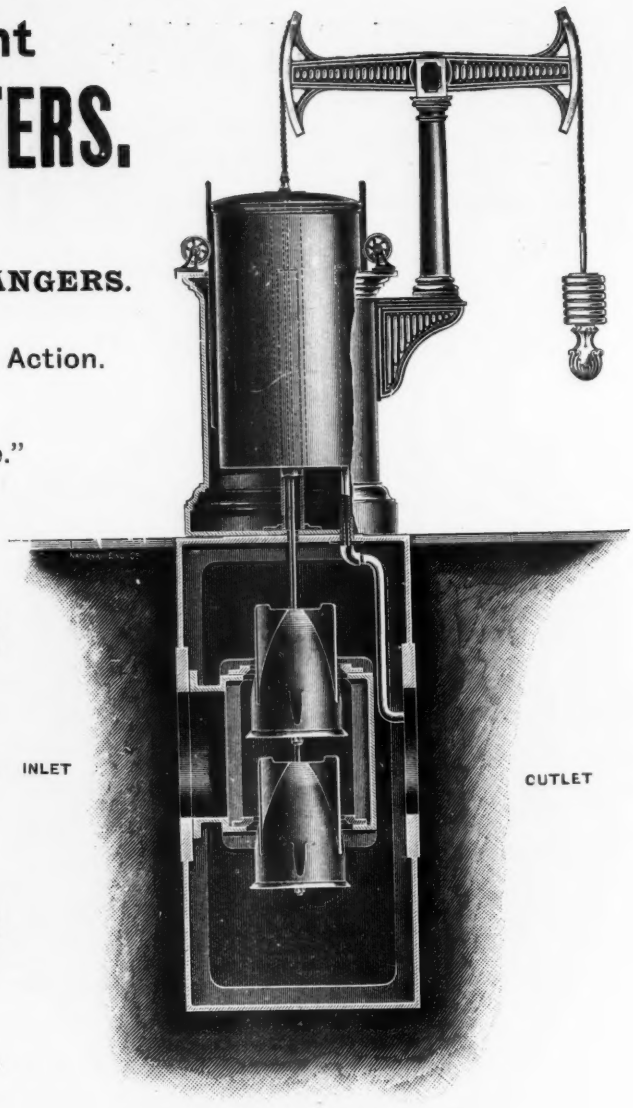
MOST COMPACT AND CONVENIENT.
EFFICIENT, SAFE AND RELIABLE.

BRADDOCK'S ENCLOSED

RETORT-HOUSE GOVERNORS

ARE UNSURPASSED.

Illustrated Sheets and Full Particulars upon Application.



GOVERNOR, No. 190 Type.

IMPROVED GAS STATION METERS

(OF ALL CAPACITIES UP TO 300,000 CUBIC FEET PER HOUR).

OF SUPERIOR QUALITY AND CONSTRUCTION. ABSOLUTELY RELIABLE.
SUBSTANTIALLY MADE. BEST VALUE OBTAINABLE.

PURIFIERS

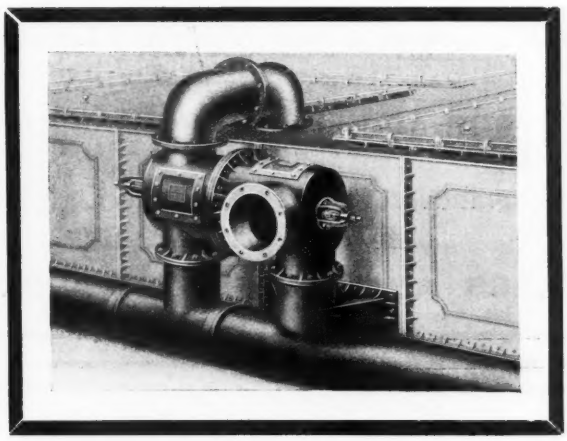
With Milbourne's Patent Valves, Cover Fastenings, Rubber Pads, and Discharge Shoots.

The Hall-Mark of Perfection in Valves.

—

Milbourne's Patent.

—



Milbourne's Patent Duplex Valve for Purifiers.

The Hall-Mark of Perfection in Valves.

—

Milbourne's Patent.

—

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DONNINGTON NEWPORT, SALOP.

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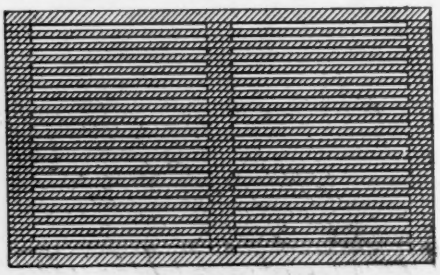
J. HAWLEY & SONS,

Manufacturers of **WOOD SIEVES FOR GAS PURIFIERS,**

WITH PATENT SQUARE IRON BOLTS.

PATENT HURDLE GRIDS FOR DEEP FILLING.



BOARD FILLING IN SECTIONS FOR SCRUBBERS.

Grid Works, PENISTONE.

ESTABLISHED 1820.

HUTCHINSON BROTHERS, LIMITED.

Manufacturers of GAS METERS, LAMPS & BURNERS, BRASSWORK, &c., &c.

FALCON WORKS, EASTGATE, BARNSLEY.

Sole Makers of

THE "FALCON" INVERTED INCANDESCENT GAS LAMP

for Street and Outside Lighting.

THE "FALCON" INVERTED INCANDESCENT CONVERSION SETS & BURNERS

for Windproof or Non-Windproof Lanterns.

THE "FALCON" ACETYLENE LAMPLIGHTER'S TORCH

for Incandescent or Flat-Flame Lighting.

PARTICULARS AND PRICES ON APPLICATION.

MOBBERLEY & PERRY OF STOURBRIDGE

LIMITED,

are now manufacturing (in addition to their ordinary "Best Stourbridge Quality") a specially High-Class Grade of Retort "BEST BRITISH" (B.B.) which for high temperatures and endurance cannot be excelled.

WESTWOOD & WRIGHTS

Brierley Hill,

GASHOLDER SPECIALISTS

(One of the OLDEST MAKERS in the TRADE),

ALL KINDS of ROOFS, PURIFIERS, TANKS, PLANT and APPARATUS required in GAS-WORKS.

CONSTRUCTIONAL IRON AND STEELWORK.

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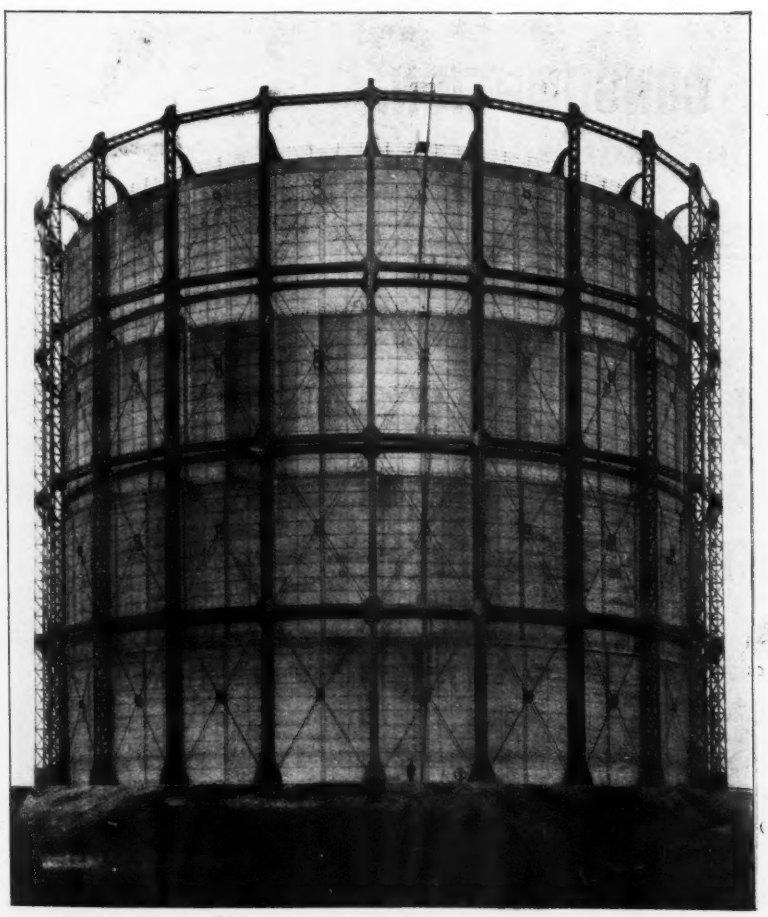
MAKERS OF
PATENT DETACHABLE FACES FOR MOUTHPIECES.



Four-Lift Gasholder, 199 ft. 6 in. dia. × 42 ft. deep, erected at the East Ham Gas-Works.

PATENTEES
of
The MOST RELIABLE GAS VALVE
with
PATENT LUBRICATING FACES
and
PATENT INDICATORS.

AUTOMATIC FASTENINGS
for
RETORT MOUTHPIECES.

PRESSURE RELIEVERS
for
GASHOLDER CUPS.

FURNACE AND OTHER DOORS
also
RETORT MOUTHPIECES
with
ASBESTOS JOINTS.

GUARANTEED RESULTS.

In all Retort Settings erected by us, we are prepared to guarantee

1. THE LIFE OF RETORTS AND SETTINGS.
2. THE MAKE OF GAS PER MOUTHPIECE.
3. THE FUEL CONSUMPTION.

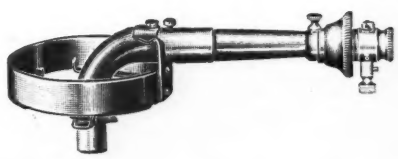
E. J. & J. PEARSON, LTD.,

STOURBRIDGE.

Telegrams: "FIREBRICK, STOURBRIDGE."

TO STREET LIGHTING AUTHORITIES.

When converting your Street Lamps to the Incandescent System, please send for our list of Street Lighting Incandescent Gas Burners. We are specializing in this department, and hold a large range of patterns—



UPRIGHT, INVERTED & ANGLE BURNERS.

The Burners are well made, highly efficient, and low in initial cost and upkeep.

GEO. BRAY & CO.

LIMITED.

Gas Lighting Engineers,

LEEDS.

London Offices:

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R. LAIDLAW & SON

(EDINBURGH), LIMITED,

Gas
Meter
Makers

AND

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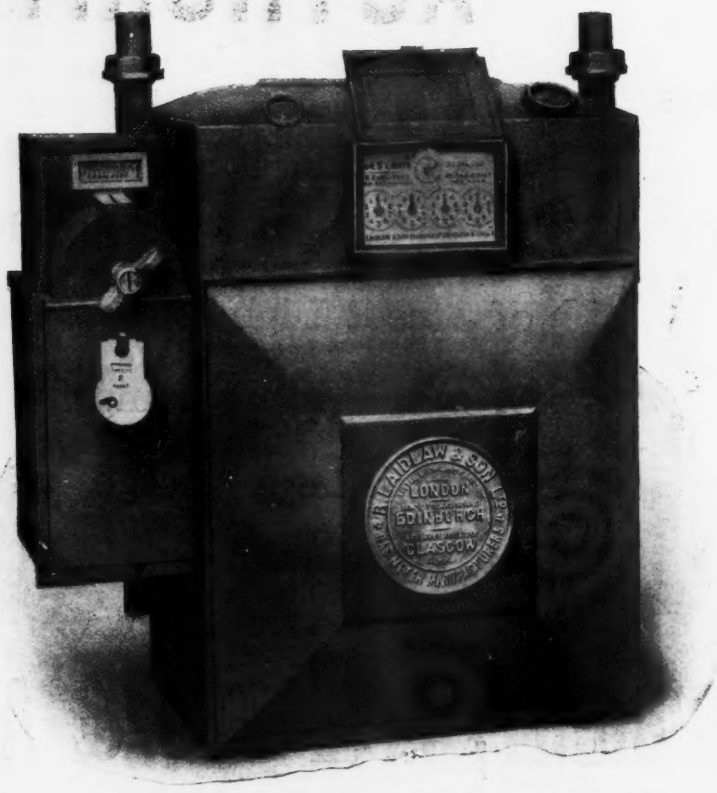
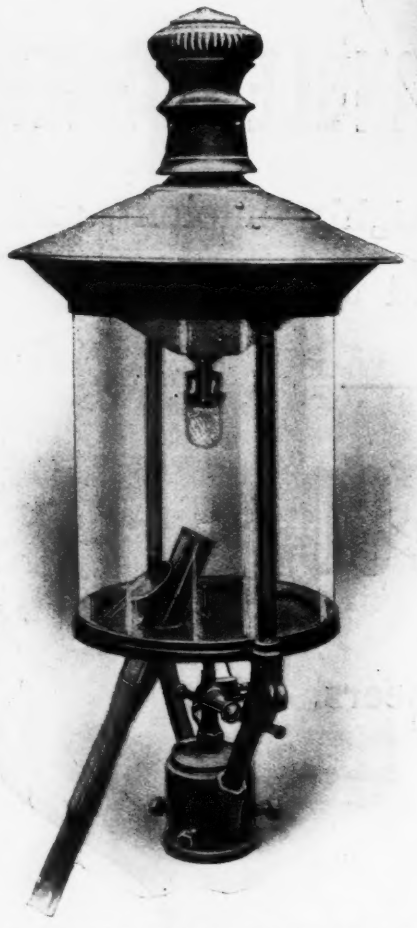
Lighting
Engineers.



P.P. METER WITH PATENT REVERSIBLE CASH BOX.



"DONWAL" SHADOWLESS LANTERN. PATENTED.

PREPAYMENT & ORDINARY
GAS METERS
In Tinplate and Cast Iron Cases
(WET OR DRY).

INCANDESCENT LANTERNS
For Public Lighting.
MAKERS OF THE "DONWAL" LAMP
AS ILLUSTRATED.

WRITE FOR PARTICULARS.

Simon Square Works,
EDINBURGH.

6, Little Bush Lane,
LONDON, E.C.

Gas Engineers.

The attention of Engineers extending their Plant is particularly drawn to PICKERINGS'

PATENT CONNECTIONLESS VALVES,

Which are now rapidly superseding all other types. The chief advantages are :—

No Connections required.
No Floor Space occupied.
No Foundations necessary.
No leaky Valves through deposit on faces.
All working parts easily accessible.
Compact, simple, and reliable.
Cost does not exceed that of other types.
No internal parts in boxes.

Prices and Particulars on application to Makers :—

ASHMORE, BENSON, PEASE & CO., LTD., STOCKTON-ON-TEES.

SPENCER'S PATENT INCLINED HURDLE GRIDS

(No. 1 PATENT).

The only Deep Grids which can be placed in Purifiers in an inclined position, so as to be Break-Joint, are

SPENCER'S PATENT HURDLE GRIDS

(PATENTED IN ENGLAND AND FOREIGN COUNTRIES).

The first Deep Grid invented, and the only one that holds Purifying Material in a light, porous condition.

MORE THAN 2000 SETS INSTALLED IN SIX YEARS.

Spencer's Patent Hurdle Grids break up the Material and suspend same in the Purifiers—a System acknowledged by all the leading Gas Engineers to be the best and most practical method yet made use of. They pass, on the average, three times more Gas per charge than Flat Grids, and reduce back-pressure more than half. The large and ever-increasing number of orders we receive from all parts of the world is convincing testimony as to their efficiency.

Spencer's Patent Hurdle Grids cost little more than Flat Grids, and their Price is saved in Two Years' working. They are simple in construction; easily fixed in position without any alterations to existing Purifiers; and being self-supporting they obviate the cost of Standards and Bearers.

The following are a few of the Places where our Hurdle Grids are in use—

Bath, Bristol, Bromley, Birmingham, Boston, Blackburn, Cardiff, Cheltenham, Chorley, Cleethorpes, Dundee, Edinboro, Halifax, Hull, Harrow, Liverpool, Lincoln, Longwood, Northwich, New Barnet, Oldham, Perth, Swansea, Salford, Sheffield, Stretford, Sunderland, Ulverston, Brussels, Buenos Ayres, Cette, Flushing, Lille, Manley, Nice, Roubaix, Singapore, Sydney, Valparaiso, Wanguani, &c.

HUNDREDS OF UNDENIABLE REFERENCES AT YOUR DISPOSAL.

W. SPENCER & SONS,

Grid Works, ELLAND, Yorks, and at SOUTHALL, LONDON.

O'NEILL'S OXIDE

SUPPLIED ON LOAN OR PURCHASE.

SPENT OXIDE BOUGHT IN ANY DISTRICT.

GAS PURIFICATION & CHEMICAL CO., LTD.,

Telegrams: "PURIFICATION LONDON." **PALMERSTON HOUSE, LONDON, E.C.** Telephone: LONDON WALL 9144.

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Gas Engineers, Ironfounders, and Contractors,

LONDON & EXETER.

Actual Makers of every description of all

GAS PLANT AND CONSTRUCTIONAL WORK.

RETORT SETTINGS	ALL THE LATEST IMPROVEMENTS.
CONDENSERS	ATMOSPHERIC AND WATER COOLED.
LIVESEY WASHERS	ORIGINAL MAKERS.
PURIFIERS	BEST AND CHEAPEST CONSTRUCTION.
CENTRE VALVES	PICKERING'S PATENT, COMPACT, COMPLETE, CONVENIENT.
GASHOLDERS	SPIRAL AND STANDARD GUIDED.
STATION GOVERNORS	PATENT EQUILIBRIUM VALVE, PRESSURE ABSOLUTELY CONSTANT. ANY SIZE.
STATION METERS	IN CYLINDRICAL CASES TO 30,000 FEET PER HOUR; IN SQUARE CASES UP TO 200,000 FEET PER HOUR.
WET AND DRY METERS	OF THE HIGHEST EXCELLENCE IN MATERIALS AND WORKMANSHIP.
SLOT METERS	FROM 2-LT. TO 100-LT. FOR ANY COIN, POSITIVE IN ACTION, ABSOLUTELY ACCURATE, HUNDREDS OF THOUSANDS IN USE.
GAS FITTINGS AND MAIN COCKS	A SPECIALITY.
SLOT INSTALLATIONS	PIONEERS OF THE SYSTEM FOR FITTING UP SERVICES, METERS, STOVES, AND GAS-FITTINGS.

SHOW-ROOMS—

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Telegrams: "WILLEY, EXETER."
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" 7495 GERRARD.

GAZINE

(Registered in England and Abroad.)

A Radical Solvent and Preventative of Naphthalene Deposits, and for the Automatic Cleaning of Mains and Services. It is used also for the Enrichment of Gas.

MANUFACTURED AND SUPPLIED ONLY BY

C. BOURNE

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SILICA

"MACHINE MADE" RETORTS

TRADE MARK **"C.O."** REGISTERED.

These retorts are now largely used and proved to be superior to **ANY** fire-clay retort.

Their qualities of not **SHRINKING OR SAGGING** mark their difference from retorts made of fire-clay, and this property of remaining stationary under working conditions places them in a class of their own.

WE GUARANTEE:

(1) That they will withstand the highest working heats.

(2) That they will not **CONTRACT, SOFTEN, SAG, OR WARP.**

WE CLAIM:

Greater efficiency than any fire-clay retort.

More durability.

That carbon does not readily adhere to them, and they are easy to scurf.

That being Machine Made they are even in texture and without joints, and having few, if any, air spaces, the conductivity is superior to any hand-made retort.

References can be given of their work in vertical, inclined, and horizontal settings.

For Particulars and Prices apply—

JOSEPH MORTON, LTD.,

Cinder Hills Fire Clay Works,

Telegrams: "MORTON HALIFAX." **HALIFAX.** Telephone: 134 HALIFAX.

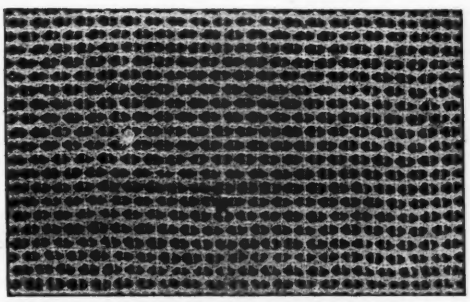
London Agents: DOW & WILSON, 32, Fenchurch Street, LONDON, E.C.

"VOELKER"

LOOM WOVEN MANTLES.

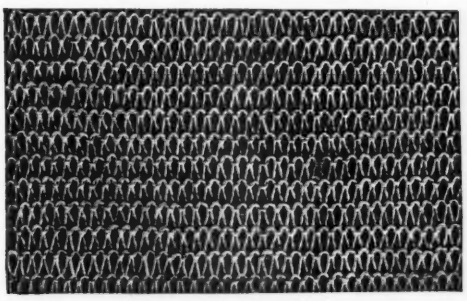
WE have had an opportunity of examining the speciality in the way of mantles with which the Voelker Lighting Corporation are having much success; and they certainly seem to mark a great advance in mantle manufacture. The secret of their strength and durability, we understand, arises from the fact that the ramie thread is woven on a loom, and not knitted on a machine, as is usually the case. There are thus no series of acute angles in the fabric, against which another thread is cutting, which is so often responsible for the breakages to which mantles are subject.

The following illustration shows clearly that the threads run in straight lines, and that no part displays an angular structure.



Loom-Woven Mantle.

In order to emphasize the increased strength of a loom-woven mantle over a knitted mantle, the following illustration gives a representation of the mesh of an ordinary knitted mantle, as usually supplied to the trade. The marked difference in the increased strength of the mesh of the loom-woven mantle must be apparent to the most casual observer.



Knitted Mantle.

We understand that a number of engineers connected with leading gas companies, after giving these mantles a prolonged test, have pronounced emphatically in their favour; and the mantles should certainly prove of great interest to all engaged in street lighting and maintenance work—*Journal of Gas Lighting.*

The Voelker Lighting Corporation, LTD.,

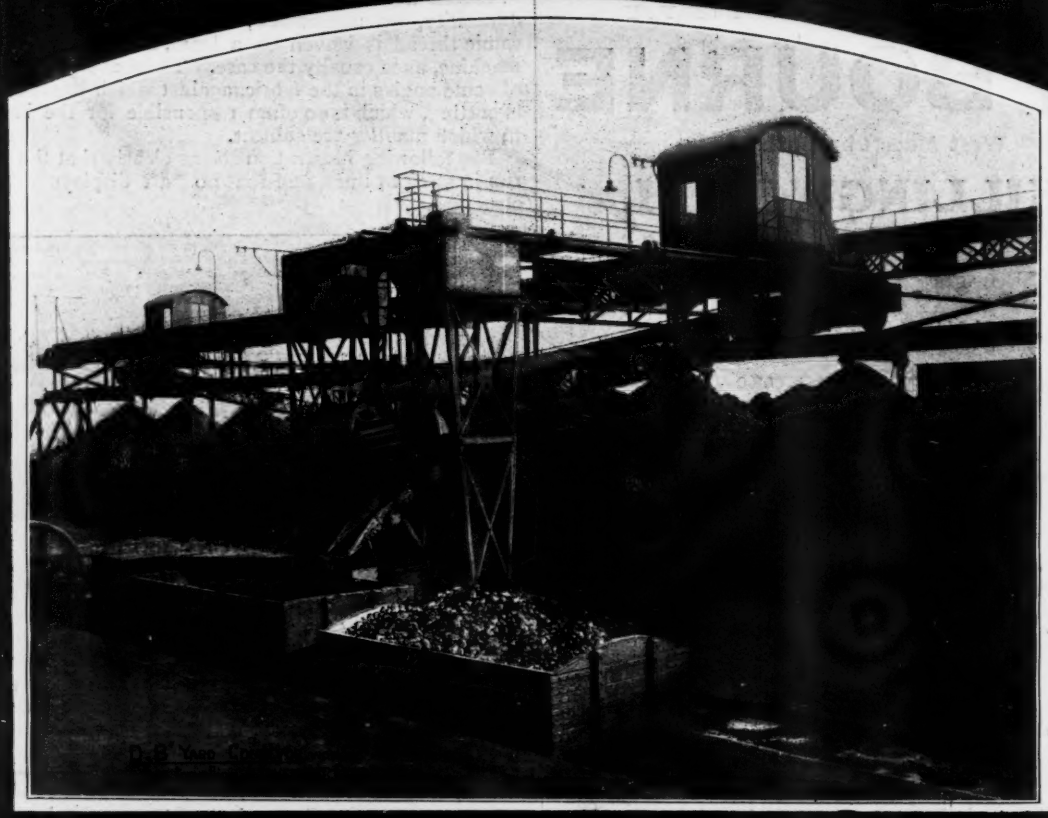
Albert Works, Garratt Lane, **WANDSWORTH, S.W.**

SIX MILES

OF

D.B. PATENT HOT COKE CONVEYORS

AT WORK



WHICH ARE

SAVING MONEY

AND CREATING RECORDS

Of lowest Maintenance and Working Costs.

SOLE MAKERS

W.J. JENKINS & Co LTD ENGINEERS RETFORD

LOWEST CARBONIZING COST ON RECORD

ONE PENNY

Per 1000 Cubic Feet of Gas SOLD

This Result was obtained at Lancaster (*C. ARMITAGE, Esq., Engineer*).

D. B. Projector Fitted with Measuring Chamber.

SOLE MAKERS:

W. J. JENKINS & CO., LIMITED,

Telephone: No. 44.
Telegrams: "Jenkins, Retford."

RETFORD, NOTTS.

Codes: A.B.C. 5th Edition
Western Union.

A GAS ENGINEER'S REMARKS?

Your Meters are Excellent! When once fixed cause NO TROUBLE and are a GREAT ADVANTAGE, SAVING TIME AND MONEY.

SPECIALTY.

Single & Double Coin Meters

and

Price Changing in situ Meters.

SIMPLE,
STRONG,
and
EFFECTIVE.

GEORGE WILSON, GAS-METER MANUFACTURER, COVENTRY.

Telegrams: "GASMETER," COVENTRY.
Telephone: 596, COVENTRY.

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SOLE LICENSEES FOR
HUDSON PATENT
PRODUCER.

F. C. SUGDEN & CO.
FOR SETTINGS!
28 EAST PARADE, LEEDS.

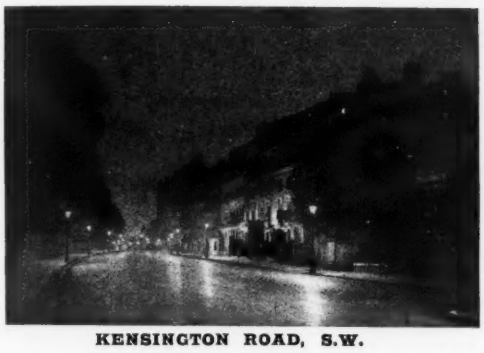
NUMEROUS
REPEAT ORDERS.

Telegrams: "CARBONIZER, LEEDS." Telephone: 3207.

"NICO" STREET LAMPS.

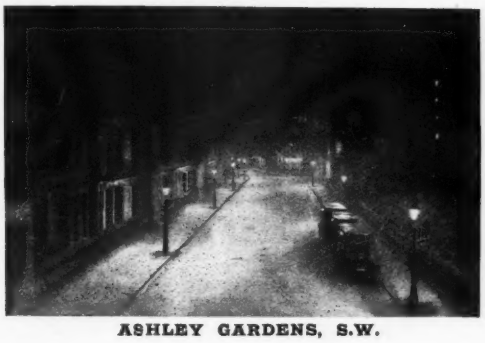
AS SUPPLIED TO

THE CITY OF WESTMINSTER, BOROUGH OF PADDINGTON, BOROUGH OF CHELSEA, BOROUGH OF FINSBURY, BETHNAL GREEN, ETC., ETC.



KENSINGTON ROAD, S.W.

Night Views of Streets Lighted by "NICO" Street Lamps.



ASHLEY GARDENS, S.W.

"NICO" STREET LANTERNS ARE MADE IN ONE, TWO, THREE, FOUR, AND FIVE LIGHT CIRCULAR, AND ONE, TWO, AND THREE LIGHT SQUARE.

Conversion Sets can be supplied for adapting existing street lamps to the "NICO" System.

3-LIGHT LANTERN.

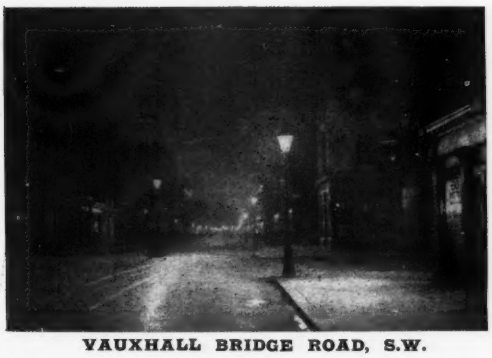
ACKNOWLEDGED TO BE THE FINEST LOW-PRESSURE LAMP OBTAINABLE FOR STREET LIGHTING PURPOSES.

"The new 'Nico' Lanterns . . . have a very graceful appearance, and examination enables one to pronounce the workmanship as being of a very high order."

Vide "Journal of Gas Lighting," Sept. 27, 1910.

BRITISH MADE THROUGHOUT.

PRINCE CONSORT ROAD, S.W.



VAUXHALL BRIDGE ROAD, S.W.

PATENTEES AND MANUFACTURERS—

THE NEW INVERTED INCANDESCENT GAS LAMP CO., LTD.

Manufactory—ROSCAR WORKS, SUMMER HILL ROAD, BIRMINGHAM.

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A.B.C. Code, 5th Edition used. Telegrams: "Promerope, London." Telephone No. 6600 Central.

A. E. PODMORE & CO.,

GAS LIGHTING ENGINEERS & PATENTEES, HIGH POWER LIGHTING SPECIALISTS,

34, CHARLES ST., HATTON GARDEN, LONDON, E.C.

Patentees of the **POPULAR LAMP**, with Dust and Insect Proof Burners.

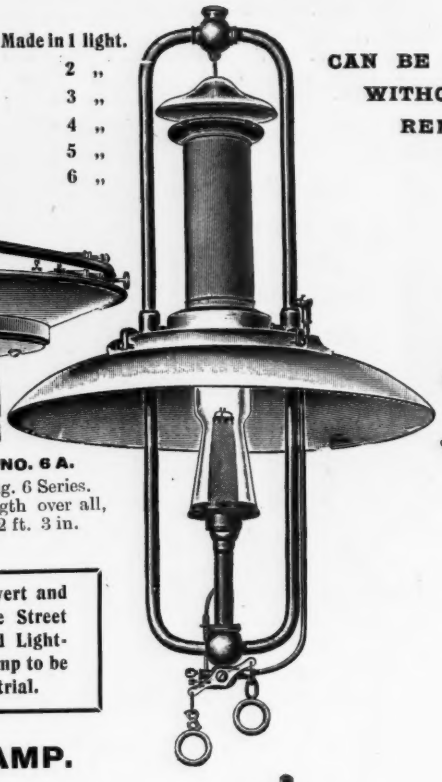
FOR ALL COUNTRIES.

DUST PROOF BUNSEN BURNER LAMPS

THE FINEST STREET LANTERN CONVERSION SET.

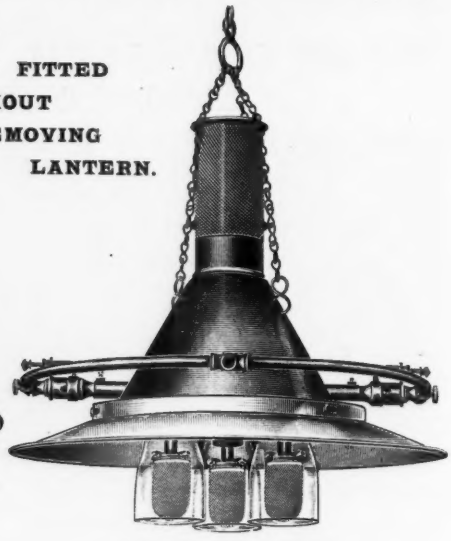
HAVE YOUR LAMPS MADE UP-TO-DATE.

Made in 1 light.
2 „
3 „
4 „
5 „
6 „



NO. 6 A.
Fig. 6 Series.
Length over all,
2 ft. 3 in.

CAN BE FITTED WITHOUT REMOVING LANTERN.



ADAPTATION SET.

We are now in a position to convert and bring up to date any well made Street Lantern from Upright to Inverted Lighting (by our system). Send a Lamp to be adapted to our system as a trial.

"PODMORE" LAMP.

No. 2003 (M.S.

3-Light Inverted lamp with Clear Globe and 18 in. opal reflector.

Electric Distant Controllers, Batteries, &c., Extra.
Lamp cases finished in White enamel and Gold Lines in Brown and Gold, or Brown, White and Gold.
These are controlled by an ordinary Bell Push Button.
One Battery will serve several lamps, but a separate Push must be used to each lamp.

THE IDEAL LAMP

For Gas Companies' Hire Purchase System.

EVERY PART RENEWABLE.

Over 30 c.p. per cubic foot consumption per Burner.

Stock Pattern Cup and Ball.
Rainproof.
Clear Globes for Renewals,
3/6 each.

Windproof.
British Manufacture.
No Cylinders required.

WRITE FOR LISTS OF ADAPTATION SETS FOR UP-TO-DATE CONVERSION.

HAVE YOU TESTED THE

"VISSO-MARSE"

Upright Incandescent Gas Burner?

No. 3—90-candle power for 3 cub. ft.
No. 0—30 „ „ „ 1 „

If not, write us and we will send you

SAMPLES FOR ONE MONTH'S TRIAL FREE OF CHARGE.

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LUDGATE CIRCUS, LONDON, E.C.

Stop Losing Money

through the lack of an automatic check on the labour you buy. Get all you pay for. **DEY TIME REGISTERS** furnish the remedy.

They put an absolutely accurate mechanical check on each employee's time, printing in two colours a complete weekly payroll on one sheet, ready for the auditor. Each man, on a single line in numerical sequence, records his coming and going automatically and correctly for the entire period.

The DEY System is the Ideal Loose Leaf System.

For time-keeping by departments in Factories, Offices, or Stores. The Payroll sheets can be placed in binders for your Loose Leaf Records. Write for our Free Booklet thoroughly explaining this new Recorder and Loose Leaf Payroll System, showing how it will save money for you.

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Telephone: Bank 5690. *Telegrams: "Countable, London."*

WELLS' "LIGHTNING" PAINTER

SUPPLIED TO 12 GOVERNMENTS, PRINCIPAL RAILWAYS, AND LEADING GAS-WORKS AND FIRMS IN GREAT BRITAIN.

(Wallwork and Wells' Patents).

PAINTING BY MACHINE.

OVER **700** SOLD.

Great Saving of Time, Paint, and Labour.

Painting Speed—3 Square Yards a Minute.

The paint is sprayed evenly and continuously through a flexible tube and nozzle supplied with compressed air, either from existing air main or from our special Compressors.

	£ s. d.
No. 1 Painter	20 0 0
No. 2 „	25 0 0
No. 3 „	30 0 0
Single Air Compressor	17 10 0
Double Air Compressor	27 0 0

Wells' "Lightning"

LIME AND COLOUR WASHER.

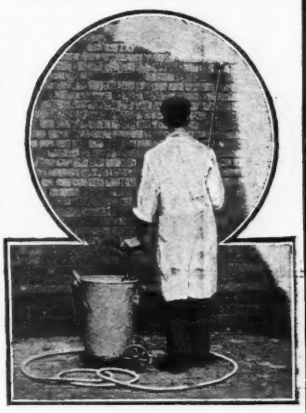
A Great Saving of **Time, Labour, and Money.**

NO OUTSIDE POWER REQUIRED.

Saves its Cost in a Few Days.

Over **5000** Sold.

(Wallwork & Wells' Patents).



Lime, Whiting, or Cold Water Paints

applied at a speed of from 10 to 20 square yards per minute, in a manner superior to brushwork. One coat with the machine on rough surfaces is equal to two applied with brushes. The material is applied in the form of a spray, and is driven into corners and difficult places where a brush would not reach.

	£ s.
No. 6 (no tank), on wheels, fed from pail	7 7
No. 6A, with detachable pail	5 15
No. 4, capacity 6 gallons	8 10
No. 4A, on wheels, same capacity as No. 4	9 10
No. 5, Large Size, capacity 10 gallons	10 10
No. 5A, with double spraying nozzle on wheels, same capacity	11 15

WELLS' WASTE OIL FILTERS.

Fitted with Patent "Sight-Feed" Syphons.

Over **18,000** *Sold.*

Invaluable to Gas and Water Companies and all Users of Steam and Gas Engines and Machinery.

Pay first cost in a short time, as Dirtied Oil which has hitherto been thrown away can be filtered and used again and again.

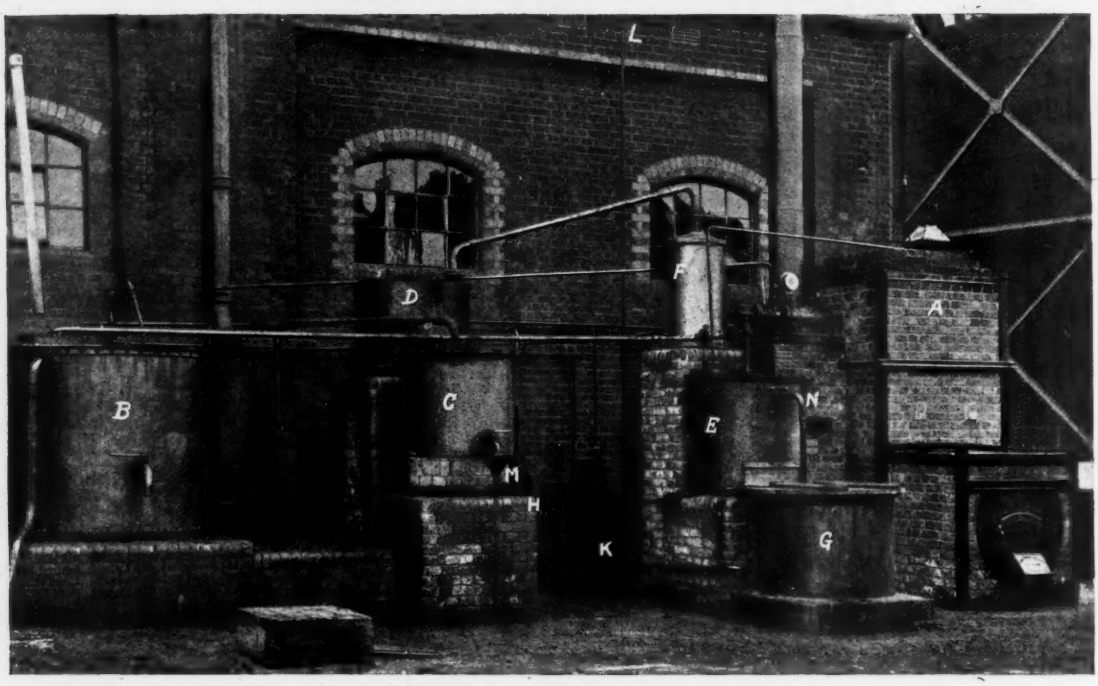
Money Savers to any Users of Machinery.

	£ s.
No. 1—For users having only a small quantity of oil to treat (no syphon), 17 in. by 9 in.	1 15
No. 2—Two top chambers hold about 3 gallons oil, 22 in. by 10 in.	2 10
No. 3—Two top chambers hold about 6 gallons oil, 27 in. by 12 in.	3 10
No. 4—Two top chambers hold about 12 gallons oil, 36 in. by 16 in.	5 10
No. 5—Two top chambers hold about 24 gallons oil, 43 in. by 23 in.	9 9
No. 6—Very powerful filter for treating large quantities of oil, 54 in. high, 30 in. diameter, fitted with two steam coils	16 16

Large Sizes made to Order.

A. C. WELLS & Co., 113, Midland Rd., St. Pancras, **LONDON.**

WILTON'S TAR DEHYDRATION PLANT.

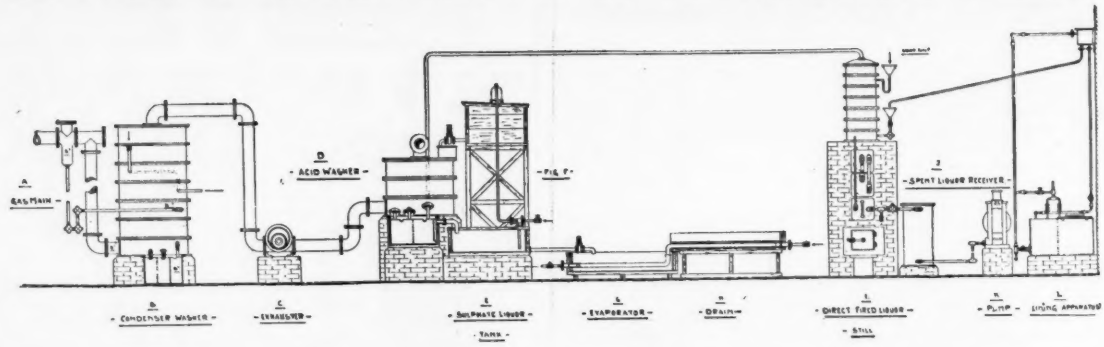


Tar Dehydrating Plant at Waltham Cross Gas-Works.

ADOPTED BY

WALTHAM CROSS, TUNBRIDGE WELLS, ALDERSHOT, LANGLEY MILL,
WOKING, MAIDSTONE, HINCKLEY.

WILTON'S SULPHATE OF AMMONIA PLANT



General View of Plant from Outlet of Hydraulic Main to Inlet of Purifiers for Cooling, Removing Tar, Tar Fog, Naphthalene, and Ammonia as Sulphate.

NO WASTE LIQUORS. **NO DEVIL LIQUOR.**
NO LOSS OF AMMONIA. **FINE WHITE SALT.**
WATER WASHING DISPENSED WITH. **LESS LABOUR.**
LESS APPARATUS. **LESS COST.**

Particulars on Application to—

THE CHEMICAL ENGINEERING CO., & WILTON'S PATENT FURNACE CO.,

HENDON, LONDON, N.W.

You cannot wish for a better Slot Cooker than

THE

TITAN

The Renewal Orders from last year's contracts prove that our efforts to produce the best are successful.

A SAMPLE COOKER WILL CONVINCE YOU ALSO.

ARDEN HILL & CO.,
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ASTON, BIRMINGHAM.

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BIGGS, WALL, & CO.,

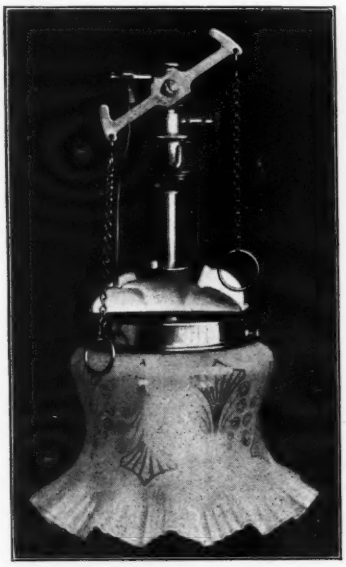
Telegrams: "RAGOUT, LONDON."

13, Cross St., Finsbury Pavement,
LONDON, E.C.
Telephone: 273 CENTRAL.

The "**BRITISH**" Burner will **NOT** overheat, and therefore can be adjusted without burning the fingers.

It will **NOT** discolour the fittings.

The "**BRITISH**" Burner **WILL** give 129 c.p. light with 4½ cubic feet of gas consumption per hour.



PRICES.

Complete as shown with Bye-pass, Levers and Chains, Fancy Shade, and British "**IDEAL**" Mantle, **81/-** per doz.

Without Bye-pass, **52/-** per doz.

SUBJECT TO TRADE DISCOUNT.

GAS FITTINGS OF EVERY DESCRIPTION.

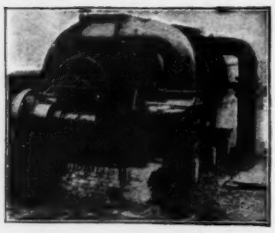
THE BRITISH BURNER

(PATENT No. 3859/09)

Is Made in England with British Material and British Labour.

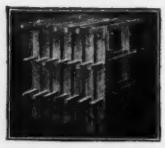
KIRKHAM, HULETT & CHANDLER, LD., 132 & 133, Palace Chambers, WESTMINSTER, S.W.

"Standard" Specialties.



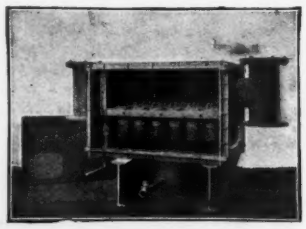
WASHER-SCRUBBER.

T.A.
"WASHER, LONDON."



"HURDLE" GRIDS.

T.N.
127 VICTORIA.



TAR & NAPHTHALENE WASHER.

Wrought-Iron

And Fittings & Accessories.

LAMBERT BROS. (WALSALL), LTD.

Alpha Works, WALSALL.

MANUFACTURERS OF
WROUGHT-IRON TUBES & FITTINGS for GAS, WATER, & STEAM.
Brass Gas-Fittings, Gas-Valves, Steam & Water Valves, Tools, &c.
LONDON: LAMBETH BRASS & IRON CO., LTD., 91 & 93, SOUTHWARK ST., S.E.

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All Bye-Products from the Distillation of Coal dealt with.

SPECIALITIES { Hydrated Oxide of Iron for Gas Purification, and of different Strengths to suit conditions of Purification, Sulphuric Acid (free from Arsenic) for Sulphate of Ammonia Manufacture, Recovered Sulphur, and Prussiates of Soda, Spent Oxide bought on Sulphur and Cyanide Contents, Tar and Gas Liquor purchased. *See our Advertisement last week.*

SAML. CUTLER & SONS, LTD., MILLWALL, LONDON.

And at 39, VICTORIA STREET, WESTMINSTER, S.W.

CARBURETTED WATER-GAS PLANT.

MAXIMUM EFFICIENCY GUARANTEED.

Inspection of Working Plants Invited.

No. 227.

THOMAS DUXBURY & CO.,

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CONTRACTORS FOR ALL QUALITIES OF

GAS COAL AND CANNEL

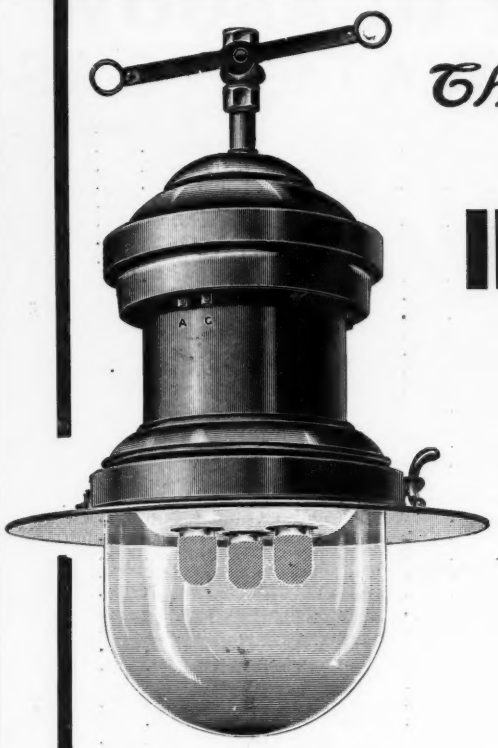
Contracts made for delivery by rail to any Station or f.o.b. and c.i.f. to any port.

Gas Engineers' Agents for **METERS, FIRE-CLAY GOODS,** and all other Gas Apparatus.

"LUX" PURIFYING MATERIAL and NATURAL OXIDE.

Telegrams { "DARWINIAN MANCHESTER." "DUXBURYITE LONDON."

Telephone Nos. { 1806 CITY, MANCHESTER. 4026 CITY, LONDON.



Made in 1, 2, 3, and 4 Light.

The "UKAY"

INVERTED LAMP

FOR EXTERIOR LIGHTING

is Specially Recommended to

GAS ENGINEERS and

LIGHTING AUTHORITIES

generally for all Maintenance Purposes.

MADE THROUGHOUT IN ENGLAND.

ALL COPPER CASING.

WIND AND RAIN PROOF. STRONG AND DURABLE.

110 Candles per Burner for 3½ cubic feet of Gas per Burner per Hour.

WRITE US FOR PRICES.

TO GET THE BEST RESULTS

USE "VERITAS" MANTLES.

THE BEST FOR STREET LIGHTING AND ALL MAINTENANCE PURPOSES.

There is no Mantle that gives such Universal Satisfaction.

FALK, STADELMANN, & CO., LIMITED.

LONDON & GLASGOW

83-7, Farringdon Road. 74-8, Great Clyde Street.

HUMPHREYS & GLASGOW

CARBURETTED-WATER-GAS

	Cubic Feet Daily
Aarhus	800,000
Agram	200,000
Alkmaar	400,000
Allenstein	200,000
Amsterdam	1,000,000
Antwerp	1,500,000
Antwerp (2)	1,000,000
Ashford	250,000
Augsburg	425,000
Aylesbury	150,000
Barmen	500,000
Barrow	300,000
Barrow (2)	500,000
Bath	1,000,000
Belfast	1,700,000
Belfast (2)	4,500,000
Benrath	125,000
Berlin:	
Charlottenburg	2,500,000
Rixdorf	650,000
Rixdorf (2)	700,000
Tegel	3,500,000
Tegel (2)	6,350,000
Bilston	375,000
Birmingham:	
Nechells	3,000,000
Swan Village	1,500,000
Windsor Str.	3,000,000
Bishop Stortford	200,000
Bochum	530,000
Bognor	100,000
Bordentown	125,000
Bournemouth	1,000,000
Bournemouth (2)	500,000
Bremen	550,000
Bremen (2)	950,000
Bremen (3)	850,000
Brentford	1,200,000
Brentford (2)	850,000
Brentford (3)	350,000
Bridgwater	200,000
Bridlington	150,000
Bridlington (2)	200,000
Brieg	100,000
Brighton	1,750,000
Brighton (2)	1,850,000
Brighton (3)	750,000
Bristol	2,250,000
Bromley	1,500,000
Bruges	200,000
Brussels:	
Anderlecht	350,000
Anderlecht (2)	350,000
Forest	1,000,000
Koekelberg	1,000,000
St. Gilles	1,000,000
St. Josse	1,000,000
St. Josse (2)	600,000
St. Josse (3)	775,000
Ville	750,000
Ville (2)	750,000
Ville (3)	1,500,000
Ville (4)	350,000
Bucarest	1,100,000
Budapest	50,000
Budapest (2)	1,750,000
Budapest (3)	200,000
Carlisle	600,000
Carlsruhe	500,000
Chigwell	350,000
Chorley	300,000
Commercial, L'n.	850,000
Commercial (2)	850,000
Commercial (3)	1,250,000
Commercial (4)	2,000,000
Commercial (5)	800,000
Copenhagen	700,000
Copenhagen (2)	2,500,000

	Cubic Feet Daily
Courtral	250,000
Coventry	600,000
Coventry (2)	600,000
Cracow	200,000
Cracow (2)	200,000
Crefeld	500,000
Crewe	700,000
Croydon	1,250,000
Croydon (2)	625,000
Croydon (3)	625,000
Croydon (4)	550,000
Debreczin	100,000
Deventer	150,000
Deventer (2)	200,000
Dorking	150,000
Dublin	2,000,000
Dublin (2)	2,000,000
Dublin (3)	650,000
Dundee	1,500,000
Dunedin	150,000
Dunedin (2)	275,000
Durham	200,000
Düsseldorf	1,000,000
Eastbourne	1,250,000
Edinburgh	2,000,000
Epsom	225,000
Epsom (2)	300,000
Essen	1,400,000
Falmouth	150,000
Faversham	200,000
Flensburg	300,000
Flensburg (2)	125,000
Forst	300,000
Frankenthal	175,000
Gas Lt. & Coke Co.:	
Beckton	2,250,000
Beckton (2)	10,750,000
Beckton (3)	5,000,000
Beckton (4)	2,500,000
Bromley	3,750,000
Fulham	2,500,000
Kensal Green	2,250,000
Kensal Green (2)	2,250,000
Nine Elms	2,750,000
Gablonz	140,000
Gelsenkirchen	175,000
Gelsenkirchen (2)	350,000
Geneva	500,000
Gosport	200,000
Göteborg	300,000
Göteborg (2)	600,000
Graudenz	200,000
Guildford	350,000
Guildford (2)	200,000
Haarlem	850,000
Hamburg	1,750,000
Hampton Court	500,000
Hampton Court (2)	600,000
Hartlepool	750,000
Hebden Bridge	200,000
Heidelberg	200,000
Holyoke	600,000
Hong Kong	450,000
Hull	1,500,000
Hull (2)	1,000,000
Ilford	650,000
Innsbruck	200,000
Ipswich	750,000
Kampen	350,000
Kiel	1,000,000
Kiel (2)	880,000
Kolozvar	100,000
Lausanne	250,000
Lausanne (2)	385,000
Lea Bridge	350,000
Lea Bridge (2)	350,000
Lea Bridge (3)	400,000
Lea Bridge (4)	1,000,000

	Cubic Feet Daily
Lawrence	400,000
Leeuwarden	400,000
Leiden	500,000
Leiden (2)	575,000
Leigh	350,000
Lemberg	260,000
Lemberg (2)	500,000
Liége	1,000,000
Liége (2)	750,000
Lincoln	500,000
Liverpool	3,500,000
Liverpool (2)	4,500,000
Liverpool (3)	750,000
Longton	600,000
Louvain	800,000
Lübeck	400,000
Maastricht	200,000
Magdeburg	1,400,000
Maidenhead	225,000
Maidenhead (2)	225,000
Maidstone	500,000
Malines	500,000
Malmö	350,000
Malta	400,000
Manchester	3,500,000
Manchester (2)	3,500,000
Manchester (3)	1,500,000
Mansfield	330,000
Marlborough	100,000
Mayence	700,000
McKeesport	500,000
Merthyr Tydfil	300,000
Middlesbrough	1,250,000
Moscow	1,000,000
Munich	1,400,000
Namur	175,000
Nelson	400,000
Newburgh	600,000
New York	5,200,000
Nictheroy	250,000
N. Middlesex	150,000
N. Middlesex (2)	200,000
N. Middlesex (3)	75,000
Norwich	1,000,000
Norwich (2)	300,000
Norwich (3)	500,000
Nottingham	1,000,000
Nottingham (2)	1,000,000
Nuneaton	125,000
Oberhausen	175,000
Oldenburg	200,000
Ostend	100,000
Ostend (2)	200,000
Perth, W.A.	125,000
Poole	1,500,000
Poole (2)	1,000,000
Port Elizabeth	400,000
Portsmouth	1,000,000
Posen	450,000
Posen (2)	700,000
Prague	140,000
Preston	1,400,000
Reading	1,000,000
Redhill	275,000
Redhill (2)	300,000
Reichenberg	200,000
Reichenberg (2)	200,000
Reval	350,000
Rhymney	175,000
Romford	300,000
Romford (2)	350,000
Rotterdam	850,000
Rotterdam (2)	1,500,000
Rotterdam (3)	750,000
Rotterdam (4)	750,000
Rotterdam (5)	600,000
Rotterdam (6)	2,000,000
St. Albans	700,000

	Cubic Feet Daily
St. Gallen	225,000
St. Gallen (2)	225,000
St. Joseph	750,000
San Paulo	700,000
Santiago, Cuba	400,000
Scarborough	800,000
Scarborough (2)	200,000
Schwelm	100,000
Shanghai	225,000
Shanghai (2)	225,000
Shanghai (3)	1,600,000
Southampton	800,000
Southampton (2)	500,000
Southampton (3)	600,000
Southgate	400,000
Southgate (2)	500,000
Southport	750,000
Southport (2)	900,000
South Shields	650,000
Stafford	500,000
Staines	600,000
Stettin	880,000
Stockholm	1,500,000
Stockholm (2)	1,750,000
Stockport	600,000
Stockport (2)	600,000
Stockport (3)	400,000
Stockton	500,000
Swansea	750,000
Swansea (2)	1,000,000
Swansea (3)	450,000
Swindon	300,000
Swindon (2)	450,000
Sydney	1,000,000
Harbour	500,000
Harbour (2)	500,000
Mortlake	500,000
Mortlake (2)	500,000
Syracuse	850,000
Taunton	225,000
Taunton (2)	350,000
The Hague	1,000,000
The Hague (2)	500,000
Tilburg	400,000
Torquay	350,000
Torquay (2)	350,000
Tottenham	750,000
Tottenham (2)	750,000
Tottenham (3)	350,000
Tottenham (4)	1,000,000
Tottenham (5)	1,000,000
Tottenham (6)	1,250,000
Tournai	700,000
Tunbridge Wells	1,000,000
Utrecht	1,000,000
Utrecht (2)	1,000,000
Verviers	1,000,000
Vienna	3,500,000
Vienna (2)	2,500,000
Waltham	400,000
Wandsworth	1,800,000
Watford	300,000
Watford (2)	350,000
Wellington, N.Z.	350,000
West Bromwich	550,000
West Ham	1,500,000
West Ham (2)	800,000
Weston-Mare	350,000
Weston-Mare (2)	350,000
Wexford	100,000
Wiesbaden	850,000
Winchester	225,000
Winchester (2)	125,000
Wolverhampton	1,500,000
Zwolle	200,000
Zwolle (2)	200,000
Zwolle (3)	700,000

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EDITORIAL NOTES—GAS, &c.

The Institution in Glasgow.

ANTICIPATION has been more than realized. Magnificent was the success of the meeting of the Institution in Glasgow last week, in the matter of the number of members and their ladies attending, in that of the technical harvest, and, last but by no means least, in that of the pleasant and happy associations, which will endure in the memories of those who were fortunate enough to be present. Glasgow was a strong magnet; and it is difficult for us to faithfully, and with a feeling of security, apportion the reason for this between the high rank of the President in the gas profession, his popularity, the traditional reputation as hosts of the civic authorities, and the specially attractive programme—technical and social—that had been arranged for the occasion. Combined, it all presented something quite out of the common. And as we look back over the week, and call to mind the large attendances and participation at the meetings and the social events—attendances and participation that were maintained from Tuesday morning to the end of the excursion on Friday—the safest and most politic course for us is to ascribe it all to the attractiveness of the programme in the whole, including the desire to honour the President and those who so worthily, and with a high sense of responsibility and business acumen, administer the affairs of the city, and who, in turn, ever show a sympathy for, and a wish to honour, all effort that is directed to progress. Illustrated here is the reciprocity of normal human nature. It cannot be otherwise, in the particular with which we are concerned, with the authorities of a city whose coat of arms bears the motto "Let Glasgow Flourish." They know full well that a great commercial and industrial community can only continue to flourish by technical and scientific advances. Therefore they give encouragement by actions far more material than any verbal expressions.

We are sure that it would not be in accord with the wishes of the gas profession generally, and more particularly of the numbers representing it in Glasgow last week, if we were not to take this the earliest opportunity of giving expression to their deep appreciation of the generous kindness showered upon the Institution by the Lord Provost (the Hon. A. M'Innes Shaw), Bailie Paxton, the Convener, Bailie Kirkland, the Sub-Convener, and the members of the Gas Committee, as well as the City Council as a whole. Long as has been our experience in these matters, we have never known goodwill, hospitality, and the manifestations of a desire to provide for the comfort, convenience, and enjoyment of the members of the Institution to be exceeded by any other municipal body. The feeling could not be avoided that the members were in the city under the protection and as guests of the Corporation; and the fact added to the lustre of the occasion and the events. From the opening of the meeting, the commanding figures of the Lord Provost and Bailie Paxton (especially of the latter) became so familiar, their *bonhomie* so transparent, their friendliness so universal among the visitors, that they appeared to be linked up in some indefinable way with the President as the heads for the time being of the Institution. The President was strong in their support; and they contributed largely, with Mrs. M'Innes Shaw, Mrs. Paxton, and Mrs. Wilson and other members of the President's family, in making (quite unconscious that they were doing anything more than duty and hospitality demanded) the week one of indelible memories. While penning this acknowledgment, the Reception Committee (who looked to the details, and whose names are mentioned in our "Social Events of the Week") must be remembered, as must also be the authorities of the Glasgow and West of Scotland Technical College, who, with a fine courtesy and promptitude, acceded to a request of the President for the use of their splendid large lecture theatre for the business work.

Concerning the meetings, and the technical proceedings, the President's Address and the largest matter for discussion—carbonization in vertical retorts—together with the Gas Heating Research Committee's report, are commented upon in subsequent articles; and there are a few points in other papers to which reference may be made next week. Though we have dealt specially with the report of the Gas Heating Committee, and have not done so with that of the Refractory Materials Committee, it is only in consequence of there being in it two or three matters which appear to point important morals. The Refractory Materials Committee's report, containing as it does a second specification and a promise of further active work, is perhaps even of more practical value, though the Committee (upon which one of the most active spirits, with Mr. James W. Helps and Dr. Colman, has been Mr. F. J. Bywater) are very desirous it shall be understood that all they recommend is subject to the revision that experience and time may suggest. But there is a large degree of confidence in what has so far been done by the presence on the Committee of representatives of the Fire Brick and Retort Section of the Society of British Gas Industries. The fusion of the knowledge of users and makers has already, inquiry assures us, acted beneficially upon the goods in question. This is how things should be. It is the height of absurdity that aloofness between users and makers should be the ground for any real inferiority.

Generally, in regard to the papers contributed to the proceedings, they were, in the main, solid in interest, in some respects they presented novelty, and, for the most part, they were of good literary character, although somewhat long. But there was not sufficient time for their proper reading and adequate discussion; and all the papers other than those on carbonizing had to be hastily read or epitomized, and the discussions, through a necessary abbreviation, were really, in some cases, barely worthy the name. The fault does not lie solely with the Council. It has been proved over and over again at these annual meetings that freedom as well as work is desirable; and a lengthening of the sittings would not be tolerated. This being so, though, with some, the nature of the communications makes fullness essential, authors might in most cases assist the Council in giving time to discussions by shortening their communications. A lengthy contribution is more often than not fatal to live, effective, and really useful discussion. But there is another side to the question. The Council ought not to accept more papers for the annual meeting than can be comfortably dealt with. If they do, or if the authors find they cannot curtail their communications, then there is the alternative suggested by Mr. A. E. Broadberry, just before the close of the meeting on Thursday, that a *précis* of each paper should be prepared for distribution before, or for reading at, the meeting, so as to economize time, and the saving be devoted to discussion. This blot on the meetings of the Institution has continued all too long; and why it has not ere this been dealt with by the Council entirely passes comprehension. The evil is recognized; but there is no remedial movement made after the recurring meetings at which members have deplored its existence. It is a pity; and we are not alone in hoping that another meeting will not come round without an earnest attempt being made to deal with it.

In acknowledging his election to the Presidential Chair (in which we wish him most sincerely such a year of successful work that the prestige of the Institution will be sensibly advanced), Mr. R. G. Shadbolt made the significant remark that the increasing work falling in the pathway of the Institution appears to suggest the division of the Council into (so to speak) water-tight compartments to deal with the several matters—this apart from the question of the broadening of the basis of the Institution, or the creation of a central organization representing (as the Institution does

not) the entire interests of the gas industry. If it is becoming apparent that there is a necessity for apportioning the work devolving upon the Council, does it not suggest that the variety of subjects coming before the annual meeting, also require a little sectionizing, so that (say) works' subjects may be discussed in one place, while distribution and commercial questions are being debated elsewhere. Even technically the greatest use is not made of the Institution. There were, for instance, a number of men at the meeting whose time could have been more profitably employed upon other topics than sitting silently listening to papers on (say) carbonization. Let us instance as coming immediately to mind Mr. E. W. Smith, Mr. F. W. Goodenough, Mr. S. B. Langlands, and Mr. W. J. Liberty. Those engineers and managers who could not attend the one section through the interest at the time of the other section would have the opportunity of reading later the reports of the proceedings of the section from which they were absent. The suggestion has also been heard of an autumn meeting for the special consideration of distribution, commercial, and cognate matters. We are not attached to any particular plan; but by some such means there would be an increased accumulation of experiences and expert views. Something really ought to be done to relieve the congestion—the detrimental congestion—which now occurs at the annual meetings. Meanwhile it would not be a bad thing if some of the Institution papers were discussed by the members of District Associations at next winter's meetings. The authors, we venture to think, would not find it a difficult matter to communicate through the technical press a reply to the discussions, other than those at which they could conveniently be present. This, however, is but a general matter growing out of a memorable meeting, among the interesting and instructive features of which was the lecture, which was largely attended, of Professor W. A. Bone on the subject of "Surface Combustion," a full report of which appears elsewhere in this issue.

The Presidential Address.

A BROAD-GROUNDED philosophy — from a mind highly intuitive and cultured by experience and observation—ran through the address delivered by the President. It was practical in word, thought, and view; and from it the practical engineer and man of affairs stood out with perfect clearness. But of this the writer himself—modest as ever, though occupying the highest official position in the profession on the occasion—was palpably unconscious. Conspicuous, too, throughout the deliverance was the duty of the man occupying a position of chief executive control. His thoughts are first for the well-being of the concern with the interests of which he has been entrusted, travelling from the *alpha* to the *omega* of the services to be performed and rendered by the concern, and withal recognizing that the one concern is but a unit of an extensive industry, and that its fortunes are bound up inseparably with that industry in its entirety. That is the position and the attitude we would it were possible to say are universally to be found in the life of the industry. The President has, during the more strenuous part of his professional career, grown with an undertaking —and a municipal undertaking—that projects upon the notice of the students of the gas industry as a pattern of prudent administration, underlying which is the policy of the cheapest possible service to the community, consistent with financial stability, without claiming (as at one time there was a right to claim, but which right has been recently extinguished by Parliament) the application of profits to the relief of the rates, for purposes that are altogether foreign to the objects of a gas undertaking. If all gas undertakings under municipal control were administered on similar politic lines, it would largely silence criticism, and force, by the circumstance, the hostility to the principle of municipal trading far into the background of controversial matters. Still, from his, in large measure, exceptional point of view, the President, in discussing the relative advantages and disadvantages of municipal and company trading, is found, and was bound, to say that, "taking all things into consideration, "gas companies possess the greater powers and qualifica-"tions for making their undertakings successful." That is a generous recognition from a municipal officer. The fact, however, is due to their comparative freedom in commercialism, to the personal interest that directors have, and to the absence of those encompassing influences that vex the souls of councillors and officials, and cripple action in municipal trading and management.

Prominent in the mind of the President in inditing his address was the material development of the gas industry—not only in business, but in methods and processes, in the claims upon it, and in the new conditions which have grown about it with an insistence that only serves to mark with greater impression its inherent vitality. But taking a retrospective glance over his year of office, and applying the experience gained by intimate contact with the internal affairs of the Institution, there is no question that the President is deeply disappointed with the inability, under present circumstances, of the chief organization of the gas profession to keep pace with the development of the work of the industry. "Work, and possibilities for work, by our Institution grow "rapidly year by year; and it is almost impossible for us, "however much we may apply ourselves, to feel satisfied "with the rate of progress made in dealing with the many "questions affecting our industry that are awaiting solu-"tion." There is condemnation in this. "There are so "many problems to be dealt with, that we appear to be "making little headway." Why is this? "But possibly, "as in former days, the efforts may yield their fruits in "due season." There we have just a ray of hope from the midst of a cloud of despair. "Possibly, as in former "days!" There we have the secret of the whole position, and of the confessed inability of the Institution to effectively cope with the present conditions. The Institution belongs, in its constitution and methods, to those "former "days;" its development has not kept in line with the internal developments and work of the industry, nor with the conditions with which the industry is surrounded. It has not, as an organized body, answered to the stimulus that the industry has provided; and, under its present constitution, it has proved itself incapable of doing so. It is to be hoped that the Committee who have this matter in hand will consider this. The President refers to the surprise of those outside the industry that there should be "so many problems "to solve in connection with such an old-fashioned industry "as gas manufacture." We object without qualification to the use of the term "old-fashioned." The industry may be old; but that it is "old-fashioned" the City of Glasgow itself, and every other city and town in the country in which the gas undertaking is administered on progressive lines, offer a stout denial; and so does the President when he asserts that there never was a period when the manufacture of gas, and the methods of using gas to advantage, were the subjects of such keen attention and promise as they are at the present day.

We pass on. The President finds, by a cursory glance over the accounts of gas undertakings, that there does not appear to be the same extension and percentage increase in the sales of gas now as were registered in former periods. We could hardly expect that there would be, considering the volume of gas business to-day, and how the volume of increase must therefore necessarily represent a smaller percentage increment on that business compared with the smaller volume of business of former days. If we take the past twenty years during which the volume of the gas business of the industry has doubled, there is not to be found another score of years in which the volume of accretion has been on anything like the same royal scale. If we look at the figures of the Glasgow Gas Department, as incorporated in the address, it is seen that the quantity of gas made in the past twenty years has more than doubled. In 1890, it was 3,059,277,000 cubic feet; in 1910, 6,977,904,000 cubic feet, which is no less than 859,350,000 cubic feet in excess of the doubling of the volume. It is interesting to follow the President in his examination of the course of the development of demand. The summer demand has been making good progress; the winter and night demand, in Glasgow, has remained nearly stationary—due more to the improved efficiency of gas-burners than to competition. This has irrefragable proof when he is able to point to ordinary consumers whose accounts for lighting, through simply a change of burners, has diminished 20 to 50 per cent., and when he can point to a considerable number of consumers who have installed high-pressure systems whose consumptions run into reduced figures as high as 70 per cent. Under such circumstances, it is a matter for real wonder that the sale has been maintained during the lighting period; it is a matter for rejoicing that it has been. We are brought face to face with the agreeable and salient fact that the diverse character of the business of the gas industry is its greatest security. If sales of gas for lighting purposes are practically stationary (it is not so in all supply areas),

the winter consumption has its scope, to which no limit can be applied, in domestic heating and industrial applications. And in connection with the former, the gas-fire is, as the President shrewdly observes, its own best advocate. The directions of the development of the gas industry are as clearly defined to-day—never more so—as anything can be; and it is the lowest possible price for a gas of a respectable thermal value that is required in furthering the development along the natural lines, both in the interests of the industry and of the community at large.

Works, capital, and business policy all bear upon the question of price; and, in the address, there is sketched a description of what has been done in connection with the gas-works and the management that combine to make the Gas Department of Glasgow one of the most economically operated concerns in the country. Its outstanding capital is low—£352 4s. 10d. per million cubic feet sold. Let it be said here that (as was seen at Provan) in Mr. William Foulis, the President had an excellent leader as an investor of capital for the department. There are many points of technical interest in this particular connection to be picked out of the address concerning both the Glasgow gas and chemical works. By way of example. Though there is no saving in fuel by outside producers in the equipment of a retort-house, an unrivalled time-experience points to their value in respect of labour costs, regularity of temperature in the settings, better carbonizing returns, and longer life of retorts—those in use now have variously registered lives from 1243 working days to 2059 days. Glasgow belongs to a school in gas engineering and management where the results prove the correctness of the teachings; and those lines in respect of management were perpetuated by Parliament when the Corporation Gas Consolidation Bill was before them a short while ago. Parliament then acted with deliberation; but even better than Parliament itself was fully aware of in the interests not only of Glasgow but of other places. Discussion of this matter led the President into a pronouncement of views on the subject of depreciation, in regard to which, and the reasoning, there must be common accord among gas engineers. It is only right—it is the only true policy—that consumers should pay their share of the general contemporary depreciation (including obsolescence) that goes on in connection with such a large undertaking, and which depreciation is not met by ordinary current maintenance. But the rates of depreciation charge allowed by Parliament in the case of Glasgow must not be taken, particularly the rate for works, as of general application, though most of the other items will be found to be on a fair scale. The President himself foreshadows that the time may approach when Glasgow will have to ask for a revision in this regard.

It was expected, and the expectation was fulfilled, that the President would devote part of his address to the question of carbonization, in view of the work upon which he has been engaged in connection with vertical retorts. In this matter of carbonization, we have passed from improvement to improvement almost unconsciously; and, when there has been any new introduction, its full import has not always been seen until after many days. It has taken a long time to gather together all that the vertical-retort system means in the matter of the scientific and the economical carbonization of coal, and to get well into mind the several threads composing the skein of effects. It has also taken time to ascertain whether the systems (or which of the systems) that have been most prominently before the gas industry are (or is) applicable to specific local conditions. These matters have not yet been determined by all undertakings. The President appears to have definitely resolved that they are not best suited to his circumstances; hence he has been working on totally independent lines—resulting in the development of what he has named the "continuous-"intermittent" system; the origin of the term residing in the fact that production is continuous, the charging and discharging intermittent. The character of the coal used, and the local requirements as to gas and coke from the coal, have been the potential influences in the design. The process followed has been described frequently, so that there is no necessity to repeat the details now. But experience has enabled the President to place his finger on parts of the original organism of the design that it has been possible to dispense with or to modify; thus considerably simplifying the structure as a whole. From his explanation of these, we can see an initial capital economy, and an economy in upkeep. The experimental setting has also disclosed an improvement in results that, in comparison with horizontal work with machine operation using hard non-caking Scotch coals, satisfies the President. It may be assumed, with a fair amount of assurance, that in the short reference to this subject in the address, the President has revealed the lines of immediate carbonizing development so far as Glasgow is concerned. After the morning's work in coal breaking and elevating, he thinks that, to the ordinary spectator, the future retort-house will be quiet and uninteresting. We hardly agree as to the uninteresting part of it. To learn of so much result from so little noise, fuss, smoke, and dust, will be a matter of supreme interest, it may be imagined, even to the ordinary spectator.

We have devoted much space to the Presidential Address. Its practical character deserves it. It brings before us, in so plain a manner, the throbbings of an industry full of life and possibility, of an industry that has never before stood firmer or more secure in the matter of its service and power, and of an industry that has an immense work before it. Recognizing all which should stimulate everyone concerned to do his part in seeing that nothing is left undone that will advance the work, and thus the interests, of our well-favoured industry.

Carbonization in Verticals.

The feature of the technical proceedings at the meeting was undoubtedly that of carbonization in vertical retorts. For the first time, in regard to the three prominent systems—the Dessau, Woodall-Duckham, and Glover-West—information was presented concerning their operation under lengthy working conditions in English gas-works. The papers combined give us an entirely new starting-point for consideration; but if any gas engineer has hoped that the communications would supply him with the means of making definite comparison on all points, he finds himself grievously disappointed. The three papers that treated of the working of the systems under home conditions were those of Mr. C. Dru Drury (Dessau), Mr. J. P. Leather (Woodall-Duckham), and Mr. J. G. Newbigging (Glover-West). But one cannot take Mr. Drury's paper, and compare the details of his intermittent system and working with those of the continuous system and working of Mr. Leather and Mr. Newbigging. The coals used are not the same, the details are not in line, and there are several omissions. The same applies to the two continuous systems. While Mr. Newbigging's paper is full of detail, that of Mr. Leather follows quite distinct lines. The Carbonization Committee, in their annual report to the Council, render no assistance; and Dr. R. Lessing's report (prepared under instructions from the Committee) pictures only the progress, so far as it is known, on the Continent. Again the President, with his continuous-intermittent system, does not pretend to enter the competitive lists; for the references to the system in his address clearly show that the design has been developed solely for the purpose of dealing with Glasgow conditions. If we turn to Mr. Philip Holmes Hunt's paper—narrating the circumstances under which he proceeded, as well as the lines he adopted in proceeding, to select a carbonizing system (the Dessau was favoured, as being most applicable to his coal, labour, and other conditions) for a new retort-house—it is found that some of the points that weighed heaviest with him would not apply in all cases. If Mr. Leather's paper and that of Mr. Newbigging are read in conjunction with that of Mr. Hunt, the tangle is intensified. It is plain that every engineer must apply on his own account, if he wants to adopt a vertical system, a large amount of "gumption" to the selection, which must be made in the light of his own particular local circumstances—one local circumstance being the class of coal with which he has to deal, and another the character of the coke that he desires to supply. Both the continuous and the intermittent systems have certain individual merits, when examined from the standpoint of local conditions.

This view is taken by Dr. Lessing in his report on Continental progress. He remarks, as the result of his survey, that "the impression is forced upon the impartial student "that, taking all points into consideration, there is not much "to choose between the various systems, and that the final "tests in each case would depend upon local conditions and "requirements." He also finds that the results of carbonizing trials, in many instances, still lack the uniformity of conditions which are indispensable for a comparison of real value; and he points to the impossibility of having such tests carried out under like conditions on plants varying

widely in size, arrangement, and testing facilities. But he makes a suggestion. He ventures to think that matters could be greatly simplified by standardizing at least the expression of results. The very same suggestion was made by us at the time of the great inclined retort controversy—long before the new systems of working horizontal retorts had appeared upon the horizon. Mr. W. R. Herring followed up the suggestion, and prepared a scheme for producing a comparable statement of working results; but it was not generally adopted. The papers and the discussions at the present meeting emphasize once again what was put forward years ago, and the resurrection of which we find (appropriately to the position in which the carbonizing question stands to-day) in Dr. Lessing's report. Chaos notwithstanding, it is quite easy to trace in the present papers distinct progress and individual developments in both the intermittent and continuous systems—particularly in the matter of labour, fuel, and effects that are subsidiary, but valuable, to the excellent carbonizing returns. What each system is attempting is the attainment of higher working and productive efficiency, each on its own lines. This being so, it would be a positive pity if, at the present time, any pronouncement were made, under the seal and sign of any authoritative body, that might, in any way, give superior honour to one system, so aiding its commercial interests to the detriment of technical development. This is not the time for stereotyping, by any such act, anything in connection with carbonization. Time and developments give liberty to change of thought; and a study of the papers read at the meeting induce this expression of opinion, which we believe will be that of many readers.

A few of the lessons of the papers and of the discussions may be emphasized. There is first the question of capital costs. It is generally known that the capital expenditure per ton of coal carbonized for vertical settings is heavier than for horizontal ones with machine equipment. But, on the other hand, capital expenditure must always be considered in relation to net earning capacity. If savings are effected that make the additional expenditure per ton of coal-carbonizing capacity a profitable one, then it is an excellent investment. Mr. Hunt says, in regard to the Dessau system of the latest design, that with it such savings are effected. Taking a 250-ton installation, he computes that the annual savings would, under his Melbourne conditions, represent £1287, which would be equal to 12·87 per cent. on the expenditure over and above what modern horizontal settings with machinery would cost. Mr. Newbigging, if he were to express himself in a similar way, would say that, with the Glover-West continuous system, he finds the same thing. He also raises a new point which applies only to the continuous system; and it is that, with his installation, he finds, through the production of gas being uniform in volume, that condensers, washers, scrubbers, and purifiers which were formerly barely sufficient to deal with 500,000 cubic feet per day on his former intermittent working at the Droylsden station at Manchester, are now equal to 630,000 cubic feet. It is a point that would be worth further investigation before laying too great an emphasis upon it. If, however, it is true, then to raise the effective capacity of the plant between carbonizing and storage by 26 per cent. is a matter of some value and to be reckoned among the advantages. There is the question, too, of the smaller ground space required by vertical settings than by horizontal settings machine charged which will have, in some cases, a distinct bearing upon the question of capital expenditure.

Touching further the same point, there is the lessened production of sulphur compounds in vertical working, which enables the entire elimination of lime purification, and causes oxide purification to suffice. Mr. Drury also refers to the necessity for washing the gas made in his horizontal retorts with a solvent for naphthalene, whereas he has no need to wash the gas from the Dessau verticals, owing to the low naphthalene content. The same applies to the continuous system. Apart from make and quality of gas, the coke, tar (including reduction of the free carbon in the tar), and ammonia results, as well as the low amount of carbonic acid and nitrogen in the gas, are also points that must be set against increased capital expenditure; and every engineer must consider whether, in his particular circumstances, they justify the extra cost. There is one thing to be regretted in respect of the capital costs quoted in the papers by Mr. Drury and Mr. Newbigging (Mr. Leather does not give particulars for the Woodall-Duckham system); and it is that they are not comparable. Mr. Drury's figure gives the total amount for the bench complete, exclusive of foundations and coal and coke handling plant; while Mr. Newbigging quotes a figure that embraces foundations, retort-house, bench with all fittings, coal and coke handling plant and the driving-engines and house. What appears in the papers, however, in this regard is subject to the statements made by Mr. P. G. Moon, Mr. Drury, and Mr. Leather in the discussion. Then, again, the value of Mr. Drury's figure will be modified by the new design of Dessau setting. From all which it is seen how much we are at sea, notwithstanding the copiousness of the information vouchsafed at the meeting.

It is generally admitted, too, that labour costs are lower with the vertical system than with the horizontal system. On this point, Mr. Leather does not throw any light. Mr. Hunt claims that the newer system of Dessau setting of three rows of sixes, in which three retorts are manipulated simultaneously, takes the lead in lowness of labour costs in the retort-house. There is no definite figure in the paper; but Mr. Charles Hunt places it at about half the Sunderland figure. With the earlier type of setting, under the Sunderland conditions (which are explained in the paper and reply to the discussion), Mr. Drury quotes 7·25d. per ton. But Mr. Newbigging, with the Glover-West system, names, with his comparatively small installation, 4·2d. per ton; and he looks for further reduction with extended carbonization.

Now as to working and productive results, apart from the beneficial ones already referred to in dealing with capital and labour. There is first the question of the fuel account; and it is clear that for lowness of fuel, the Glover-West system has taken the lead. There is not a retort system for gas-making purposes that utilizes within the setting to such good purpose so large a proportion of the calorific value of the fuel put into the setting as this particular one. Mr. Philip Hunt and Mr. Newbigging acknowledge it; and the inventors deserve the highest credit for it. But, on the other hand, though the fuel account is rather high at Sunderland for the Dessau system, there are two points in connection with it that somewhat discount the difference as shown by that installation in comparison with the Glover-West at Droylsden. In the design of the Dessau setting developed subsequent to the Sunderland installation, the retorts have been so modified, re-arranged, and packed into the setting, that a much greater retort-heating surface is presented to the charges; and a better and more economical use is therefore made of the fuel. The second point is that the steaming that takes place, and increases the gas production, naturally makes demand upon the fuel account; and for this credit should be given. We are afraid that, coke being a residual, such full consideration is not always given to the fuel account as there should be. It is really remarkable what a comparatively small saving in fuel per ton of coal carbonized will amount to in the course of a twelvemonth.

Upon the point as to productive results, it is a pity that Mr. Leather had not an independent purifying plant and means of measurement at Burnley for dealing with the gas from the Woodall-Duckham settings, the same as Mr. Drury has for the Dessau settings at Sunderland, and Mr. Newbigging has for the Glover-West installation at Manchester; for then we should have had really comparable results from the three systems. It is true the Lausanne works, with the Woodall-Duckham system, are complete and so comparable. But there is a felt difference. The British gas engineer wants to know the results obtained under home conditions of which he is fully cognizant; but, at the same time, the results produced at Lausanne—some with well-known brands of English coal—compel recognition both for good makes and calorific value. A yield nowadays with almost any coal (just pick out and see the varieties of coal mentioned in the four papers and the discussion) that is below 12,000 cubic feet per ton is out of the running, and at that figure a high-grade illuminating and calorific power gas is realized. But if the figures are taken out and tabulated, it will be observed that nearer 13,000 cubic feet is a common make with verticals to-day; and upwards of 14,000 feet of 15½-candle gas with South Yorkshire coal is also mentioned by Mr. Newbigging. There is a point here to be noted. The highest makes mentioned in the papers, with the lowest illuminating powers, give the greatest number of B.Th.U. per ton of coal carbonized. Does not this point clearly to the direction of future work—the production and selling of the greatest number of B.Th.U. at the lowest possible price? In this connection, it is interesting also to note

that, with gentle, regulated steaming, as in the Dessau system, during the last two hours or so of a charge, an increased production, of about 1000 cubic feet, is obtained; and yet the illuminating and calorific power (as shown by Mr. Drury) is only fractionally depreciated—the depreciation being, in fact, practically negligible.

There is only one more point to remark upon on this occasion. It is this: It is demonstrated conclusively that there is an improvement in the coke made by verticals in comparison with horizontal working. It is further proved that, with certain kinds of coal, the intermittent system of working will produce a more compact coke than the continuous system. These points are clear; but there appears to be some misconception abroad as to the effect of the travel of the charge through a continuous retort in twelve hours. Some engineers speak as though they picture the coke in a condition subject to deterioration travelling the full length of the retort, and constantly on the move. But does it not occur to them how, in the continuous system, the charge passes well down the retort before being, practically speaking, denuded of its volatile constituents, and before reaching the state in which movement might affect it? The movement, too, is very gentle. Then, again, there is a large amount of gradual cooling, instead of violent quenching in a highly incandescent state with, at any rate, one system. With mechanical charging at top and mechanical discharge at the bottom of a retort, there may at times have been found, at Burnley, a little looseness in the charge; but now that the Woodall Duckham setting has been adapted also to the gravity charge system, occasional inconvenience in this respect need not be experienced. Though the papers that were read at the meeting on the subject of verticals were so largely antagonistic in certain matters of detail, they have helped to clear the ground in several respects, and they have brought to the front distinct evidences of progress, though the veins of partiality running through the contributions help to confuse the issues.

[Comments on other papers are deferred to next week.]

Last Work of the Gas-Heating Research Committee.

THE final report of this Committee, which was presented at the meeting, records that the work which has been carried out during the past three years by Mr. E. W. Smith, under the surpervision of the Committee, has been brought to a close, owing to Mr. Smith having entered the service of the Birmingham gas undertaking. It will be noted that the Committee have not thought it worth their while to ask for reappointment, partly owing to the loss of Mr. Smith's services, and partly owing to the establishment of an Advisory Committee (consisting largely of representatives of the Institution of Gas Engineers) at Leeds University, which Committee should be in a good position to continue the researches carried out by the Gas-Heating Research Committee, as well as to extend them in any direction which may prove desirable in the near future.

The researches recorded in the report presented last week fall into two series—viz., those relating to the relative radiation efficiency in gas-stoves of fuel gases of lower calorific power than coal gas, and experiments relating to the construction of the burners of gas-stoves. In regard to the first series, two types of low power gas were investigated—viz., water gas and Mond gas. The water gas, which was not carburetted in any way, had a calorific power of about 67 calories net per cubic foot at 60° Fahr. and 30 inches bar., which is about half the calorific power of the coal gas used in the tests of gas-stoves referred to in the report of the Committee issued last year. [We regret to see that the Committee in this last report have adopted the scientific, as distinguished from the technical laboratory, method of expressing the rate of consumption and calorific power of the gas in terms of cubic feet measured at 0° C., 760 mm., and dry. Every technical gas man is thus put to the trouble of converting the figures in the report to the corresponding figures in the ordinary standard conditions, adopted not merely in the works' laboratories and offices, but also in official gas-testing places, before he is in a position to institute comparisons with other figures. We hope that the Leeds University Advisory Committee will see to it that this pedantry drops out of any similar report which may be issued under its auspices.] Regulating the water gas to the most suitable rate of consumption, a radiation efficiency of 41·6 per cent. was secured from a stove which, with coal gas in normal conditions, had a radiation efficiency of about 38 per cent. The appearance of the water-gas-heated fire was, however, inferior to that of the coal-gas-heated fire. Apart from this question of appearance, it would seem that water gas is as suitable a fuel as coal gas for use in gas-stoves; and it is only a question of the relative cost of the two gases, and of the rates of consumption. Actually the stove consumed about twice as much water gas as coal gas. No sane technical man would dream of proposing, in the conditions of gas supply prevailing in this country at the present day, the substitution of uncarburetted water gas for coal gas for public supplies. The experiments of the Committee are nevertheless very valuable, in that they indicate that, in so far as it may be economically sound from the manufacturing and the distributing standpoints to incorporate a fairly large proportion of water gas with coal gas, the consumer of gas will not suffer a reduced radiation efficiency from his gas-stoves. Seeing that even now the gas supplied in the Metropolis north of the Thames has a calorific power considerably less than the coal gas used in the former experiments made for the Committee, the results of the present investigation of the radiation efficiency of water gas in gas-stoves, should satisfy the London consumer that the trend of policy in recent years, in the direction of reducing the high quality of gas supplies, is not really working to his disadvantage.

The experiments made with Mond gas led to a strikingly adverse conclusion in regard to the possibilities of its employment in gas-heating stoves. The Mond gas had a calorific power about one-half that of the water gas used, or approximately a quarter that of town gas. The consumption required by the stoves, after great modification of the burners in order to make them at all workable with Mond gas, was about four times as high as that of coal gas in normal conditions. The maximum radiation efficiency obtainable was, however, only 30 per cent. as compared with the 38 and 41 per cent. obtainable respectively with coal gas and water gas. Moreover, the Mond gas in other respects behaved badly in the stoves. It is not surprising that a so-called heating gas containing, as the Mond gas used did in this instance, 17·6 per cent. of carbonic acid, should fail to give the high temperature which is necessary to secure a good radiation efficiency. The same disadvantage of Mond gas must obtain also in other applications of gases to heating purposes. It is only in the larger sizes of gas-engines, where a diluted charge presents some advantages, that Mond gas can present any claim to be technically and economically equal to the richer fuel gases which constitute the ordinary town supplies.

The second section of the report of the Committee deals with the examination of the burners and nipples in use in various types of gas-fires. In this examination the Committee were verging on more delicate ground than in the first section of their investigation, because a detailed report of the results observed would, as is stated, bring into special prominence, for inferred praise or censure, some of the appliances now on the market. Large commercial interests would thus be touched; and the report would consequently have been received with criticism not altogether of an impartial character. By refraining from giving full details of the investigations made, the Committee have avoided rousing the animosity of those interested in types of burner construction which do not come up to the standard of perfection which the Committee lay down. As a result, however, of this reticence on the part of the Committee, it is rather difficult for anyone not directly interested in the manufacture of burners for gas-fires to draw useful conclusions from the report. Moreover, the investigation on the burners was not complete when the Committee lost the services of Mr. Smith, and decided to discontinue the work in this direction.

Gas Price and Coalite at Plymouth.

GAS at 1s. 6d. has been for some years the goal of the Plymouth and Stonehouse Gas Company's ambition. To-day the price is 1s. 7d. per 1000 cubic feet; and with the little extra push on which Sir Joseph Bellamy laid some stress at the annual meeting of the shareholders last Thursday, the 1s. 6d. level should not be far off. The effort and the present attainment are alike commendable. A year ago the Company broke new ground by reducing the price to 1s. 8d. per 1000 cubic feet; for the lowest price in its history had previously been 1s. 9d. Now the Directors have felt warranted in taking off another penny; and if this reduction

has the same stimulating effect upon consumption as the last, and the coal and other markets continue favourable, there would seem to be a reasonable hope that the record for price in Plymouth may again be lowered. As matters stand, the Directors and officers of the Company have every reason for satisfaction. Plymouth has always stood well in the matter of cheap gas; and many towns more favourably situated as regards access to the coalfields and in other ways, may well envy its possession of low-priced gas. The position the Company occupy has not been won without hard work and foresight. In early days the expenditure was rigorously restricted without starving the undertaking. In recent years there has been a more lavish expenditure of capital to meet the rapidly-growing demands of new consumers. But this outlay, like that of former days, has been prudently managed, and the consumers no less than the shareholders have benefited by it.

The fact that the control of the Company is in capable hands is seen by the decision to reconstruct what is called the old retort-house. It is not many years since this was the new retort-house—enlarged, fitted with new retort-benches on the most approved regenerative principle, and with machinery of the most up-to-date kind. To-day there is a prospect of achieving better and more economical results with still newer machinery; and so the old plant is to be scrapped, and new installed. The machinery is to be of the Fiddes-Aldridge simultaneous discharging and charging type; and with it are to be combined a Telpher plant in the coal-store and a system of conveyors and bunkers for transporting and storing coke. Great economy should result from the installation of mechanical appliances for dealing with both coal and coke; for though the retort-house has a producing capacity approaching 3 million cubic feet of gas per day, the coke is wheeled out and slaked by hand, and a good deal of hand labour is also required in the coal-store.

It is interesting to notice that one reason which Sir Joseph Bellamy gives for the decision to put in new plant is that compensation must be found for the loss of profit which has occurred through the cessation of the work of the British Coalite Company at Plymouth. Amid all the loss and disappointment which have attended the operations of the Coalite people, it is like an oasis in the desert to find that someone has done not so very badly out of them. When the Plymouth Company first entered into the arrangement to find a home for a coalite plant on their works and buy the gas which it produced, it was stated that, whatever might happen, the Gas Company would not lose anything. From what is now disclosed of the terms of the agreement, it seems that the Directors of the Gas Company took full precautions to guard the interests of the shareholders. They recognized from the beginning that coalite was not their business. They wanted no share in it as a speculation, but were willing to buy the gas which was to be a bye-product of the manufacture of coalite. Under the agreement, the Coalite Company were bound to supply a certain minimum quantity of gas; and in the event of failure to do so, they were to reimburse the Gas Company for any extra outlay they incurred in purchasing coal to make up the deficiency. Having regard to the numerous alterations of the coalite plant after its installation at Plymouth, it is not surprising to learn that the Gas Company had to grant extensions of time, and that the minimum quantity of gas was never forthcoming. The Gas Company, however, got what was supplied at a price at which they could not make it themselves; and, for the rest, they appear to have been as lenient and generous as, under such a business arrangement, was possible. This chapter in the history of the Plymouth Gas Company closed with their taking over part of the coalite plant, instead of insisting upon the cash payment of £1000 which the British Coalite Company had incurred by failing to carry out the agreement. Sir Joseph Bellamy spoke in a very friendly way of the Coalite Company and those who are associated with it; and it is pleasant to know that, although there is disappointment on both sides, there is no rankling sense of ill-will. The Chairman of the Gas Company dissents from the suggestion that the Coalite Company's want of success in Plymouth was due to the climatic and other conditions of the town. Nevertheless, it is true that, for a considerable part of the year, the consumption of coke or any similar fuel is very low in Plymouth, and that cheap gas is a formidable rival all the year round to coal, coke, or coalite. To say that the Coalite Company would have met with no better success elsewhere, is to admit the public do not want coalite.

One other topic in the prolific speech of the Chairman of the Plymouth Gas Company calls for brief remark. The Company, after long consideration, have decided to adopt the co-partnership principle in the case of the majority of their employees. For the present, members of the clerical and engineering staffs, who have been and are in receipt of a bonus, will not come under the scheme; but otherwise it is to be of general application. We have no doubt that it will be as well received, and produce as satisfactory results, as similar schemes in other gas-works. For many years now the relations between the Plymouth Gas Company and their workpeople have been highly satisfactory; but the Company and the workmen will both benefit from the still closer bond which will knit them together as partners in the undertaking. The scheme put forward by the Directors is designed, like most others of the kind, to encourage thrift on the part of the workmen, as well as to provide them with direct interest in the business. It has the advantage of a handsome introduction in the decision of the Directors to put it in force as from March 31 of last year; so that every man who comes in as a co-partner will immediately have credited to him 4 per cent. on the amount of his wages for last year. This year, with gas at 1s. 7d., he will be entitled to 5 per cent. on his earnings. It will be interesting to know how the men receive the offer, and how the scheme works. The strong probability would seem to be that, after it has been a short time on trial, the Directors will be asked to extend it to all their employees.

The Public Lighting Question in Holborn.

The question of the lighting of the public thoroughfares is still occupying the Holborn Borough Council. At their meeting last Wednesday, they had before them reports on the subject by a Special Committee of the entire Council and by the Finance Committee; but no decision was come to upon them. The Council have had submitted to them a joint tender by the Gaslight and Coke Company and the Metropolitan Electric Supply Company, Limited, under which it is proposed to allocate 966 lamps to electric lighting and 879 to gas lighting. The major part of the high-power units are to be gas, to the number of 67 1800-candle power lamps in High Holborn, New Oxford Street, Kingsway, Shaftesbury Avenue, &c.; while 20 lamps of similar candle power are to be electrically lighted in High Holborn and New Oxford Street. The Electric Supply Company take a large number of 400-candle power lamps in the second-class streets, the Gas Company, in their turn, having nearly the whole of the 300-candle power (four-burner inverted) and the 180-candle power (two-burner inverted) lamps. The subsidiary streets are divided nearly equally between 90-candle power inverted gas and metallic filament electric lamps. It will be observed, from what appears elsewhere, that the amount of the tender is now £6950 per annum for installing and maintaining suitable lamps and fittings and for supplying electric current and gas to give a minimum light of 424,140 candles. This compares favourably with the Gaslight and Coke Company's tender of January last—viz., £7527 for 405,000-candle power. On the figure of £6950, the joint contractors insist upon an increase of 10 per cent. if the penalty clauses of the contract are retained; making the tender £7645, or an increase of £695 per annum. To this increase the Council, in their dilemma, agreed when sitting *in camerâ;* and in their report they recommended accordingly. Unfortunately, this time it was the Finance Committee who, figuratively speaking, applied the brake to the wheel, with a hint of a surcharge on the members for spreading expenditure over a period of years without obtaining the sanction of the London County Council to a loan. After some discussion, the recommendation of the Special Committee, together with the report of the Finance Committee, was referred to the Works Committee. The Paddington Borough Council were in a similar dilemma when recently entering into their ten-years contract with the Gaslight and Coke Company for lighting the streets of the borough. But they came to a decision on the main question at once, subject to the County Council granting the necessary loan; and this consent was easily obtained.

Discussion at the Waverley Association Meeting: A Correction.—In the report of the meeting of the Waverley Association of Gas Managers in the last number of the "JOURNAL," Mr. H. O'Connor is made to state that he had not heard of anyone using his patent. This was not what he meant to say, as the patent is in use in a number of places, but that he had not heard of the effect under discussion from anyone using the patent.

THE INSTITUTION OF GAS ENGINEERS.

PROCEEDINGS AT THE NINTH ANNUAL GENERAL MEETING,

HELD AT THE

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE,

JUNE 13, 14, and 15, 1911.

MR. ALEXANDER WILSON, OF GLASGOW, IN THE CHAIR.

REVIEW OF PROCEEDINGS.

(For Full Report see page 837.)

THOSE who had any fear that the selection of the great industrial and commercial Metropolis of Scotland this year for the holding of the annual meeting of the Institution would, through distance, affect detrimentally the attendance at the meeting, had their fears quickly put to rout on Monday. The change from London was evidently gladly welcomed—not because the members do not like assembling in London, but because they were aware of the warm-hearted manner in which Bailie Paxton (now the Convener of the Corporation Gas Committee) journeyed up to the Metropolis a year ago, and in the name of the Lord Provost and citizens of Glasgow invited them to hold their meeting this June in Glasgow, during the presidency of Mr. Alexander Wilson, the city's highly esteemed Gas Engineer. They also knew that Glasgow does nothing in a half-hearted manner. After midday on Monday, nearly every train that arrived in the city appeared to add to the numbers of assembled gas engineers and their ladies. They came from all quarters. Only the coast lines of England and Wales, Scotland and Ireland can comprehend the geographical limits within which contribution was made to the gathering. We will venture to say it was a record muster. The President was proud of it. The Lord Provost (the Hon. Archibald M'Innes Shaw), Bailie Paxton, and the Sub-Convener (Bailie Kirkland), and all the members of the Gas Committee and of the Corporation, were pleased and proud that there was such a really magnificent response to their invitation.

So it came about that on Tuesday—when the morning broke brightly, and the sun refused to be kept from doing its duty to Glasgow, its citizens, and its visitors, by any murkiness of the atmosphere for which the city is noted—the large lecture hall of the Glasgow and West of Scotland Technical College was well filled when the Lord Provost and the Convener and Sub-Convener of the Corporation Gas Committee accompanied the President and the members of the Council of the Institution on to the raised platform, to extend to the visitors a welcome, from every word and act in which the spirit of heartiness appeared to diffuse through the whole meeting. The civic dignitaries wore the emblems of their respective honourable positions. Notable, by virtue of their offices, among those who accompanied the President were the Vice-Presidents (Mr. R. G. Shadbolt and Mr. J. Ferguson Bell), the Hon. Secretary (Mr. S. Y. Shoubridge), and the Secretary (Mr. Walter T. Dunn), who was alert as ever in settling the details for the conduct of the meeting. It was also noticed with pleasure that Mr. J. W. Helps was back again (after the temporary break through indisposition) amid the scenes in which he has found so much interest and so much pleasant work. Professor Arthur Smithells was also there, representing the Leeds University. A little later Mr. Henry L. Doherty, who is on a visit to this country, and who is a worthy representative of the gas industry of America, was asked to occupy a seat by the side of the President. In the gallery, a number of ladies, among whom were members of the President's family, were interested spectators of the animated scene. These were among the things noticed as the Council were settling in their seats.

There was a round of applause. The popular President was on his feet, introducing to the visitors the Lord Provost, who at once extended a cordial welcome to the members, expressing the hope that they would find much to interest them in the city, and that they would take pleasant memories away with them. When his Lordship claimed that the gas undertaking of Glasgow was second to none in the United Kingdom, there was no contradiction from the long rows of members facing; but, on the contrary, there was ardent confirmation. When he said that the members were fortunate in the selection of their President, and the Corporation in the selection of their Gas Engineer, there was endorsement of the sincerest order. We heard the name of Mr. William Foulis, who has left a big memorial in Glasgow as an economist, engineer, organizer, and progressive. Reminder was given that he occupied the presidential chair when the Gas Institute met in Glasgow 24 years ago; and we may add that he was President of the Incorporated Institution of Gas Engineers when that organization held their autumn meeting in the city in 1896. He helped to lay well the foundations of a prescient and forward gas policy in Glasgow; and his successor, shaping his acts to the times, treads well in his footsteps. The Lord Provost and his colleagues, hearing the acknowledging words of the President and the lusty applause of the members, were made well aware of the appreciation of the visitors who were partaking of the hospitality of the city.

Questions of Reconstitution and Awards.

Promptly a few items of business were cleared off the *agenda*. Among them was the question of the adoption of the annual report and accounts of the Council, in association with which Mr. George Helps called attention to the fact that the report indicated that nothing definite had been done in the matter of the reconstitution of the Institution; and he—our friend from Nuneaton can be very sage when he likes—let fall this little epigrammatic remark, which seems to contain a word of reproof, "We should think more of our industry than of ourselves." He also considered it time that the Institution, in addition to making awards for papers, should give awards to men whose work represented technical progress—such as the workers in the carbonization field and in the utilization of coal gas for heating purposes. Though a twelvemonth has passed since the matter of the reconstitution of the Institution was raised, the President confesses it is still in abeyance for a little time; but he has not the slightest doubt that his successor in the presidential office will give this as well as the several other matters raised his earnest attention during the coming year.

Upon this there came the awards for the papers read last year. Cheers accompanied Dr. Davidson as he ascended the platform to receive at the hands of the President the London Gold Medal for the paper detailing his researches at Birmingham into the question of the carbonization of coal. Dr. Davidson has taken a stand in this matter from which he is not at present prepared to shift. Mr. Abady was unable to be present to personally take charge of the silver medal for his contribution, which presented public lighting from the municipal point of view in an altogether new light. But Mr. S. Y. Shoubridge was there to receive the bronze medal for his paper on the new installation he had made of De Brouwer stoking machinery and conveying plant. De Brouwer! The name reminded of the loss that the gas industry and the Society of British Gas Industries have sustained by the death of Mr. W. J. Jenkins, whose work did much to cause the plant with which he was so prominently identified to ascend to great popularity

through materializing its intrinsic merits. In a few very appropriate sentences, the President pointed to the personal characteristics—unassuming, kindly, and intellectual—of our departed friend. "Those who knew him best will miss him most." Very true!

Presidential Address.

The presidential address followed. Each President in turn feels that the preparation of an address is one of the most onerous and exacting of the tasks that fall to his lot during his year of office; and when he comes to the point at which he has to present the result of his work in this direction, the large gathering always settles down as though a heavy judicial responsibility rests upon it. The President on this occasion appeared to be entirely oblivious of all this. He entered upon and continued the reading of his address in the matter-of-fact style which seemed to indicate that he was perfectly unconscious of his environment. The interest that he sustained from beginning to end of the address plainly showed that he had made an excellent selection of material; and his manner of delivery gave just that expression to the words that imparted to them their true proportion, sense, and weight. The address was published last week; and a comment upon it appears elsewhere. But let us say here that the parts that drew the greatest applause from the members were those that referred to the frankly expressed views of the President as to the appropriation from gas profits of moneys for the relief of the general rates. There was no mincing matters with him. The President does not like the system; and he glories in the fact that Parliament has made it impossible for the successors of the present corporate body of Glasgow to plunder the gas department in the manner all too common among municipal gas-works owning bodies south of the border. If a vote of the meeting could have been taken at the time, we do not believe there would have been a single hand held up in favour of the much-abused policy continuing. There would have been incisive condemnation from the assembled members. One other point. Remarked the President: "In connection with street lighting, companies have generally to face more onerous conditions, especially when a municipally-owned electricity undertaking is a competitor." From Mr. F. W. Goodenough, whose thoughts must have been by the words flashed-back to London, there came a sonorous "Hear, hear," which appeared to condense a tremendous amount of feeling.

Arrived at the end of the presidential deliverance, Bailie Paxton asked permission to move a vote of thanks to Mr. Wilson. Among the gems of his accompanying words—they are good orators in Glasgow—were acknowledgments of the work that the President does for Glasgow, and of the excellent state in which the great organization of which he is the executive chief is maintained. With a candour that his imposing presence seemed capable of defending even in the first arena of local politics, Bailie Paxton also stated—and he appeared to mean it—that the Gas Committee could get on very well, and indeed much better, if they had not the City Council to contend with. Looking at the address from the technical point of view, the Senior Vice-President, in seconding, had nothing but praise for it—especially for the part referring to the President's work in connection with vertical retorts.

The next matter on the *agenda* was the consideration of the reports of the various Sub-Committees.

Continental Carbonizing Position.

Acting on the instructions of the Carbonizing Committee Dr. R. Lessing had prepared a report showing the position of carbonizing practice on the Continent; and this (in the absence of the Chairman of the Committee, Mr. Charles Carpenter) the Hon. Secretary (Mr. S. Y. Shoubridge) presented; and it was adopted without a single remark. It was a very formal acceptance and passing. There was nothing of the "well done" spirit about it. The report gave, in a compendious form, much information that has already seen the light of day at greater length—focussing it all, as it were, and adding supplementary facts, from which points of view it is valuable. A great deal of research is necessary before one can construct a report of this nature; and Dr. Lessing is to be congratulated upon being able to say so much in such a little space. In this review, we must still further narrow-down what he has to say. The complexity of the problems connected with modern-day carbonization remains; and since the last report that Dr. Lessing made, little that is new in principle or application has transpired. The long-desired settlement of the question as to which is the best carbonizing system has not been effected; and controversy over it continues unabated. The proceedings at this meeting adequately portray the position. The outlook, as Dr. Lessing says, is not a hopeful one with reference to clearing up the differences involved. On the Continent the controversy has been largely confined to intermittent verticals and chambers.

Heavy-charge carbonization has conquered a good deal of ground, but has not been adopted much on the Continent. A trial or two has been made in Germany; in France and Italy, a tendency to heavy and full charges can be traced. The capital and working expenses of the inclined system in comparison with the new systems of operation have discouraged extension. Continuous carbonization in vertical retorts has come to stay. "British gas engineers may congratulate themselves upon having once more overtaken, by the continuous systems, their Continental brethren in peaceful rivalry." The Continent can only boast of two installations of continuous retort plant. But as soon as these types of plant enter the front rank of competitive systems as they have already begun to do, the difficulties of choice will be enormously increased. We take it Dr. Lessing means this to apply to the Continent. The Woodall-Duckham system is in operation at Lausanne; another plant has been ordered by the Dresden Corporation on what is known as the improved slot principle; and a plant on the same system is in course of erection at Ipswich (Queensland). The Glover-West system is not yet represented on the Continent; but it is going in at Tokio, Newcastle (New South Wales), and at Fitchburg (Mass.). Touching intermittent verticals, the Bolz system is registering for itself some good experience. As to the Dessau system, the rapid rate of expansion of 1907-8 has not, Dr. Lessing says, been maintained. Nevertheless, the number of retorts erected or in course of construction during the last two years outside the United Kingdom has reached the very considerable total of 2282. The new type of Dessau setting—in which the retorts are set in three rows of sixes, in which the heating surface is increased, and three retorts are manipulated simultaneously, with a saving in labour, fuel, and space—has special notice as a distinct advance. As to chamber settings, the number erected and under construction since June, 1909, is nearly 1000, with a daily productive capacity of upwards of 70 million cubic feet. The spread of coke-oven gas distribution for town supply in Germany—a matter to which references have been made frequently of late in the pages of the "JOURNAL"—is also alluded to.

Concluding, Dr. Lessing, glancing over the record of what has been done, remarks: "The impression is forced upon the impartial student that, taking all points into consideration, there is not much to choose between the competing systems, and that the final decision in each case will depend upon local conditions and requirements." There are differences in the bye-products and naphthalene. He also remarks that the published results of carbonizing trials are in many instances lacking that uniformity of conditions which is indispensable for a comparison of real value. Although he is well aware that it would be impossible to have tests carried out under the same conditions on plants varying widely in size, arrangement, and testing facilities, he ventures to think that matters would be simplified by standardizing at least the expression of working results. Two appendices give the number of Dessau vertical retorts and of chamber settings with their capacities, either erected or under construction since June, 1909.

Gas-Heating Research.

The second of the reports to be considered was that of the Gas-Heating Research Committee, which for two circumstances has been dissolved. The removal of Mr. E. W. Smith, M.Sc. (who has been acting as Research Chemist), to fill the office of technical head of the high-pressure gas section of the Birmingham Corporation Gas Department, and the forming of the Livesey Advisory Committee, rendered expedient, it was considered, the step of ending the independent existence of the Gas-Heating Research Committee. So in the report we have the final communication on this particular work of the Committee and of Mr. Smith. The report has two sides. It is devoted to the results of tests with water gas and Mond gas, undertaken for the purpose of studying the effect, or radiation efficiency, of the calorific impoverishment of gas and of marked changes in the composition of gas. Admittedly less exhaustive are a series of

tests relating to the construction of gas-fire burners. These are not conclusive; but it is hoped that value will be found in their suggestiveness.

In Mr. Smith's experiments with water gas, with a calorific value of 78·83 calories gross, all the primary air had to be dispensed with, using a stove which, with coal gas, had a radiant efficiency of 38 per cent. The rate of water-gas consumption was 38·6 cubic feet; and the percentage of heat radiated was 41·57 per cent., which is a higher radiant efficiency than with coal gas. But, on the grounds of cost and appearance, the use of water gas is hardly practicable. With Mond gas of a calorific value of 38·57 calories gross, it was not found possible to obtain a higher radiation efficiency than 30 per cent.; some difficulty being experienced in getting a sufficiently large consumption of gas into the stove. The stove with coal gas required about 20 cubic feet an hour; with Mond gas, and all the primary air-inlets closed, when a consumption of 80 cubic feet was reached, the flame appeared at the top of the fuel, and was so attenuated that there was practically no contact with the fuel. Fuel with narrow passages did not give a better radiation efficiency. The information is interesting, and in a measure valuable. Beyond, it serves no practical end.

Of more general value is the examination of some of the burners and nipples used in the present type of gas-fire; but this is more a matter for the designers of gas-fires than for purchasers and users. The report sets out the underlying principles to be observed in constructing a gas-fire burner, in order to obtain on one and the same burner a series of flames identical in shape. This can only be done by constructing the burner so that the same pressure is obtained at each of the flame jets. The simpler the system of tubes in burner construction the better; and of the burners examined, those which most nearly approached in construction a flat rectangular box with flame jets attached to the top narrow edge, gave the greatest evenness of flames. The essentials of a burner to meet the wide range of pressures to which a gas-fire is subjected are also discussed; and it is pointed out how absolutely necessary it is that the nipple and burner together should be capable of as wide a range of aeration as possible. As a result of the experiments, it is found by Mr. Smith advisable to have a nipple bored with three, four, or five holes instead of with only one or two, and to control the passage of the gas through the nipple by cutting out (when reducing consumption) one or more holes instead of by turning off the control tap, or in some other way cutting down the pressure at the jet or jets. The details of what follows must be obtained from the report. We are sorry the investigation had not been completed when the work was discontinued. But this must be said, in acknowledgment of the labours of the Committee and of Mr. Smith, that the results have been exceedingly suggestive as to what is right and what is wrong in designing a gas-fire. To their work, improvement has been traced; and it will also have its impress on future improvement.

The remarks that Mr. Smith made when presenting the report contained points of interest supplementing the work outlined in it. His intercourse with the gas-fire makers has brought to his knowledge that most of them are now employing research chemists; and that they have fine laboratories in full swing, in which really good permanent research work is going on. He made a suggestion, with which we are afraid the firms who are doing this work for their private advantage will probably not agree—that the chemists should have conferences, and in some way co-ordinate their work. Mr. Smith claims as one good effect of the Gas Heating Research Committee that there has been a remarkable increase in radiant efficiency—for instance, with 16-inch stoves he finds some fires give up to 60 per cent. of radiation efficiency. He also thinks there is a great deal of work to be done on the question of burners and fires. It was thoughtful of Mr. John Bond, in moving the adoption of the report (which Mr. W. R. Herring seconded), to acknowledge the indebtedness of the Committee and the Institution to their Chairman (Professor Arthur Smithells) and to Mr. Smith. The practical suggestion fell from Mr. George Helps (who discussed superficial areas of nipple apertures and burner nozzles, pressures, and much else of cognate importance) that when, if ever, the work is continued, a burner maker should be put on the Committee. As to the resumption of the work, it gave immense satisfaction to the members to hear from Professor Arthur Smithells that it is not likely it will remain suspended for long; and that it will be one of the questions the Livesey Advisory Committee will have to consider. He claims that the work of the Committee has been of value to the gas-fire makers; and, this being so, it proves the utility of the labours of the Committee.

Second Refractory Materials Specification.

The second report of the Refractory Materials Committee, of which Mr. James W. Helps is Chairman and Mr. F. J. Bywater the Hon. Secretary, presented their second report. Its adoption was moved by Mr. Helps, who hopes that the work of the Committee will do something to relieve the reproach that the fire-clay retort and brick makers of this country cannot do so well as their competitors abroad. The present report (which has been drawn up by representatives of the Committee, under the Chairmanship of Dr. Harold G. Colman, and of the Retort and Fire-Brick Section of the Society of British Gas Industries) is largely constituted of a specification for fire-bricks, blocks, tiles, &c.—the first one issued last December dealing with the manufacturing and testing of retort material. Dr. J. W. Mellor, Principal of the Staffordshire Pottery Laboratory, has again acted as technical adviser. The work of the Committee is not finished. They are going to give further consideration to the tests to be specified for porosity, particularly in regard to the chequer bricks used in the carburetters and superheaters of carburetted water-gas plants. Like its predecessor, the present specification is not to be regarded as a final one; but its clauses, as now drawn up, are intended to give a lead to development, and will be subject to revision from time to time. There is also a third specification to come, relating to silicious and silica bricks. The specification is published *in extenso* in its proper place in the report of the proceedings; and no useful purpose can be served—perhaps indeed it would be misleading—to attempt a digest of it, as many points are involved. Of its value, in conjunction with its predecessor, there can be no two opinions; and the Committee well deserved, as they received, hearty thanks for their diligence in the task allotted to them.

A remark upon the technical nature of the work on which the Committee have been engaged, led Dr. Colman to remind those present that the specifications would need revision from time to time. He requests suggestions from anyone regarding the improvement of the specifications. There was also acknowledgment from him as to the cordial manner in which the representatives of the Society of British Gas Industries have worked with the Committee. This reminded Mr. Helps that the work Mr. Bywater had done in the matter deserves the heartiest recognition. The fire-brick makers were worthily represented by Mr. G. H. Timmis, who accepted the new specification in the spirit in which it was drawn up—that is to say, as a purely tentative proposal. These are very fair words of his, that the fire-brick makers are prepared to place themselves in the hands of the engineers, if the engineers will give them credit for doing their best under the circumstances.

Carbonization—In Dessau Retorts.

This brought the members to what anticipation led them to believe would be the masterpiece of the meeting—the papers and the discussion on carbonization. They were not disappointed. The subject had a very large part in the proceedings, and carbonization in vertical retorts in particular. It still keeps its hold upon the British gas engineer, who wants to know more of experiences and results under home working conditions. He has them in the three papers that were presented on this occasion by Mr. Charles Dru Drury, on the "Dessau Vertical Retorts at Sunderland," by Mr. J. P. Leather, on the "Woodall-Duckham System at Burnley," and by Mr. J. G. Newbigging, on the "Scientific Carbonization of Coal." In a fourth paper, Mr. Philip C. Holmes Hunt told how he proceeded about the work of selecting a carbonizing system, and the reasons that caused him to adopt the Dessau. There were magnificent samples of coke on view from the Sunderland and the Droylsden verticals.

Of the three authors, Mr. Drury first occupied the platform. The installation of Dessau retorts at the Ayres Quay station at Sunderland is of the older type of setting—each of the six beds consisting of ten retorts in two rows of five. Allowing two retorts off for scurfing, the carbonizing capacity (twelve-hour charges) is 57 tons (58½ tons full capacity) per day; and, with gentle steaming, a daily make of 720,000 cubic feet of about 15½ candle gas (No. 2 burner) is obtained, using unscreened Durham coal. The make of gas therefore averages 12,631 cubic feet per ton. The retorts have

been at work continuously since December, 1909, carbonizing to the present time upwards of 30,000 tons of coal; and yet the repairs to the settings have been of a trifling character. The amount of the contract for the bench complete, exclusive of foundations and coal and coke handling plant, was £10,210. The labour costs in the retort-house work out to 7·25d. per ton of coal carbonized, or 0·57d. per 1000 cubic feet. It is seen that provision is made (unscreened coal being used) for grading the coal to reduce back-pressure at the bottom parts of the retorts. The method of working is fully described by the author. It should be mentioned in regard to the steaming that this is subject to careful regulation; and through it a very flexible method is provided for adjusting the quantity and quality of the gas. The retorts are scurfed once, on an average, in five-and-a-half weeks. The system of heating the settings is a graduated one; the retorts being kept at a greater heat at the bottom than at the top—a typical example of pyrometrical tests showing 2370° Fahr. in the combustion chamber, 1990° Fahr. in the second chamber, and 1760° Fahr. in the third chamber—no observations being made for the fourth chamber. Stopped pipes, as understood in connection with horizontal retorts, are unknown. Pitch pans are laid on the bottom of the hydraulic main under each of the dip-pipes; but the pitch deposited in these is found to contain 25 per cent. of free carbon—the best place for the disposal of this stuff being (using discretion) in the retorts themselves, where it is not found to do any harm. The retorts are worked without a seal, except when the lids are open, when about 1-inch seal of weak liquor is used. Retort pressure tests at different hours are given in the paper.

In considering the working results that Mr. Drury communicates for the twelve months ending March 31 last, compared with the horizontal retorts at the Hendon station, there are, in relation to the question of the comparative purity of the gas, two points to be remembered. They are that the gas from the Ayres Quay vertical retorts is purified by oxide only, while that from the Hendon horizontals is treated by lime. The gas from the verticals is untreated by solvent oil for the reduction of naphthalene; while that from the horizontals is washed by solvent oil. The average quantity of gas made per ton from the verticals (using unscreened Durham coal) was 12,647 cubic feet; from the horizontals, 10,638 cubic feet. The illuminating power (using the No. 2 burner) was respectively 15·52 and 18·22 candles. The gross calorific power was 590 and 611 B.Th.U. respectively—representing, we calculate, 7,461,730 B.Th.U., as compared with 6,499,818 B.Th.U., from the gas yield per ton of coal, which is a considerable advantage on the side of the verticals. The sulphur in the purified gas from the verticals was 20·2 grains (oxide); and in the gas from the horizontals, 9·53 grains (lime). The naphthalene in the gas from the verticals was 2·54 grains (unwashed by oil), and 2·84 in the gas from the horizontals (washed by oil). There was the slight reduction of 0·24 cwt. in the coke and breeze made for sale by the verticals; but an increase of tar of 1·06 gallons, and of liquor (as sulphate) 4·59 lbs. Among the other tabulated matter is one interesting compilation showing the variations in make with and without steaming. In one instance, the steaming increased the make of gas by 1158 cubic feet; in the second, by 956 cubic feet. Through steaming, the illuminating power was reduced in the one case by only 0·24 candle; in the other, by 0·6 candle. In the first case, the net calorific power was merely reduced by 2 B.Th.U.; and in the second case, there was an actual increase of 3 B.Th.U. These are interesting and suggestive comparisons. Also included in the paper are the results of tests with 200 tons of Derbyshire coal, made in the verticals for Mr. J. Ferguson Bell, of Derby. These, too, will be found highly instructive; but, for the sake of uniformity, the calorific value might have been given (though easily worked out) in B.Th.U., instead of calories. An analysis of the gas shows the carbon dioxide is only 2·4 per cent. without steam, and with steam 2·2 per cent.; and the nitrogen, 4·9 and 4·8 respectively. The figures in the paper for the purified steamed gas from the Durham unscreened coal shows a distinct reduction of the carbonic acid, but an increase of nitrogen (difference).

Reverting to the ordinary working, the fuel (dry) account is rather high—17·8 per cent. of the coal carbonized, or 34 lbs. per 1000 cubic feet of gas made. But this is partly due to the two hours' steaming. In the newer form of Dessau setting, the fuel account is materially reduced. Mr. Drury is of opinion that Dr. Bueb and others are correct in the theory that the evolution of the gas from the coal in the retort proceeds from the outside inwards, travelling upwards by the inner core. At Sunderland, on the retort-lid being opened a deep fissure is usually found in the centre of the coke.

Regarding the residuals, the coke differs greatly physically from that made in the horizontal retorts—being denser and heavier. The tar is light and thin; and the water content low (about 1½ per cent.). An analysis shows that the free carbon in the tar only equals 4 per cent., as compared with 17·25 per cent. in the horizontals. The naphthalene, too, is low. The carbon removed from the vertical retorts per ton of coal carbonized only equalled in 1910-11 1·40 lbs., as against 3·16 lbs. from the horizontals in 1909, and 3·45 lbs. in 1910. Whatever may be the demerits of the intermittent system, it has many compensating advantages, Mr. Drury holds, when dealing with a bituminous caking coal. He details these advantages—pointing at the same time to the fact that he considers the installation might with advantage be modified so as to suit English conditions. These details, however, do not affect the principle of the system; and improvements in the directions hinted at have been already incorporated in the latest design of Dessau setting. The Sunderland installation has worked without a hitch; and it has a proved flexibility.

In the Woodall-Duckham Settings at Burnley.

It is a little unfortunate, in the cause of reliable comparative information, that the conditions of the Burnley Gas-Works necessitate the intermingling of the gas from the Woodall-Duckham vertical retorts with that produced elsewhere on the works, before a full record of results has been established—the same as is possible at the Ayres Quay Gas-Works at Sunderland and the Droylsden works at Manchester. However, in the paper with which Mr. J. P. Leather presented the members, he gave an amount of valuable information, which shows that excellent results are obtained, and that, by certain changes in detail, original difficulty has been surmounted. Mr. Leather does not dwell on the advantages of rendering the operation of carbonization continuous, as he believes that all gas engineers who have taken the trouble to consider the matter have recognized them. Personally, he is a strong believer in continuous carbonization; being convinced that "the dumping of quantities of coal into red-hot retorts, together with the discharge at intervals of large quantities of red-hot coke are things which it is desirable to avoid, if economically possible."

The disadvantages and advantages of mechanical charging are pointed out by Mr. Leather. It would be an extraordinarily perfect system that had not some disadvantages mingled with its advantages. There is the disadvantage, in this case, of requiring shafting and mechanical arrangements working in a warm and dusty atmosphere at the top of the retort-bench. Perhaps a greater fault is that, if in any way the contents of the retorts drop, an empty space is left, which is not so rapidly filled with coal as by the gravity-feed arrangement. But there are the advantages. The flow of coal can be readily observed, and any irregularity can be quickly detected. At Burnley, an experiment has been made with an arrangement in which the feed-roll is elevated somewhat from the retort; thus providing a small store of coal between the feed-roll and the retort. This alteration is found to conduce to more regular working. Means have also been adopted to enable the coal to find its way into the hot part of the retort before the outflowing gas has had an opportunity of depositing in the coal any pitchy matter tending to retard its easy flow. An arrangement for gravity-charging is also illustrated in the paper.

The coke-extractor is next described; and it is important to note that there is no tendency on the part of this to break the coke small. At Burnley there has been trouble with the long rocking-shaft driving the extractor and the discharging-drum. In the Lausanne installation, this has been remedied; and in more recent installations, the rocking-shaft has been replaced by a reciprocating-rod, which is not liable to the same faults. Another change which has been tried experimentally on two of the Burnley retorts has been to replace the mechanically working discharge-drum by a water-seal door. A little water is admitted before the opening of the door, which causes the space above it to become filled with steam, which acts as a cushion between the gas and the air. This disposes of a fear that Mr. Leather entertained as to explosions with a single door. Incidentally, it is noted that a small trickle of water is admitted into the coke-chamber in all cases for cooling purposes. Repeated analyses of the

coke produced have shown less than 0·5 per cent. of water; and not more than 0·8 per cent. of water and volatile matter combined. There is another point as to the passage of the coke. The retorts must not only be tapered considerably, but must be preserved in good shape, and free from ledges or any marked roughnesses on the interior surface. On first setting the installation to work at Burnley, trouble was experienced by the hanging-up of the charges. The fact, however, that some of the retorts worked freely with very little attention, shows that the system is not at fault. The resulting troubles caused by the hanging-up of the charges are dilated upon by Mr. Leather; but anyone now installing the system can avoid them by the adoption of reasonable precautions. Pressure in the retort, with normal working, is maintained but slightly below, or about, level gauge throughout its length.

As to results, each retort is capable of carbonizing 52 cwt. to 55 cwt. of coal per day, yielding 12,600 feet of gas per ton of Burnley coal. But there, unfortunately, so far as the gas is concerned, the information stops. The coke is excellent; and the tar shows the low percentage of 5·6 of free carbon. In some cases, it was incidentally remarked, it has been down to 3 per cent. Mr. Leather has paid a visit to the Lausanne installation; and the Engineer (M. Cornaz) kindly permitted him full access to his working records. One with Aldwarke coal showed a make of 12,863 cubic feet per ton, of a calorific value of 623 B.Th.U. gross and 558 B.Th.U. net. That is quite good. The concluding words of the paper are: "Continuous carbonization has been proved feasible; and as the conditions of smooth working are now demonstrated, it ought before long to take the place of the cruder intermittent method in all new works."

In the Glover-West Retorts.

In the next paper to which the members listened, Mr. J. G. Newbigging treated of the scientific carbonization of coal. He contends that dumping coal into retorts, causing disuniformity in their heating, and producing gas of unequal composition and illuminating and calorific power at different periods of the charges, cannot be termed "scientific." And when a process is available whereby the coal can be fed into the retorts and the spent charges removed continuously, with a high heat-utilization efficiency in the setting, resulting in an economy in the fuel account, the coke also being extracted in a comparatively cool condition, that is the process that certainly commends itself to him. He finds such a process in the Glover-West system; acknowledging in passing the work in connection with continuous carbonization of Messrs. Woodall and Duckham.

Like Mr. Drury with his Dessau verticals at Ayres Quay, Mr. Newbigging has been able to set aside the Droylsden works of the Manchester Corporation entirely for the purpose of investigating the working of the Glover-West installation that he has erected, and which installation has run with perfect smoothness for the past twelve months—to be exact from July 12 last. He acknowledges that all the advantages predicted by the inventors, and expected by himself, have been fully realized. The installation consists of two settings of eight retorts each; the nominal capacity of the plant being 500,000 cubic feet per day, though the daily output has reached 630,000 cubic feet. From 50 cwt. to 64 cwt. has been carbonized per retort per day, according to the class of coal—the travel of the coal through the retort occupying from entrance to exit just about twelve hours. The structural details are furnished in the paper. The coal gravitates from the superimposed feeding-hopper at a rate regulated by the rate of discharge of the coke-extractors; so that the elasticity of the system, according to the character of coal undergoing carbonization or the quality of the gas required, is seen without enlarging on the point. The coke-extractors being the only mechanically operated part of the settings, the power required is small. As a matter of fact, the cost of the gas used for power for this purpose only amounts to 0·714d. (at 1s. 9d. per 1000 cubic feet) per ton of coal carbonized; while the cost of gas used per ton for coal breaking and elevating and coke-raising for the producers is only 0·672d. per ton. A description of the heating of the retorts forms an interesting section of the contribution; and, incidentally, it is learned that a series of fifteen tests carried out on various classes of coal shows that the fuel account only averaged 10·04 per cent.

Mr. Newbigging does a service, as does Mr. Drury, by giving the cost of the installation. In this case, however, the price includes everything—foundations, retort-house and bench, with all fittings, coal and coke handling plants, with driving engines and house. The figure was £8150. The low labour costs and the agreeable conditions of the retort-house are commented upon. For a carbonization of 45 tons per day, three men are employed; and the total labour cost per ton within the retort-house is only 4·2d. It makes one wonder what will be the ultimate figure when we have Mr. Newbigging stating that "with 100 tons or more per day, and with the introduction of coke-handling machinery, this figure would, there is no question, be very considerably reduced." As to wear and tear, he can find no legitimate reason why the retorts should not have a life in excess of intermittently worked ones. The retorts at St. Helens have been working over 1000 days, and are in excellent condition; while with regard to the mechanism, it is simple, substantial, and slow moving, and the mechanical movements are few.

As to the results, Mr. Newbigging finds that from 500 to 1000 cubic feet more gas are made per ton of coal than from the carbonizing systems at the other gas-works of the Corporation. A Beasley calorimeter chart shows an almost regular straight line for the calorific value of the gas, whereas charts accompanying the paper indicate a wide divergence between the highest and the lowest calorific values of the gas produced in horizontal or inclined retort working. The continuous production has another effect that, within our recollection, has not been made before. It is that condensers, washers, scrubbers, and purifiers that are barely sufficient to deal with 500,000 cubic feet of gas per day on an intermittent system of carbonization have been found equal to 630,000 cubic feet with the uniform production of gas. Mr. Newbigging gives a wide range of testings for the information of inquirers regarding results of working—trials made specially for the purpose of, first, ascertaining what quantity of gas could be produced from Lancashire, Yorkshire, and Derbyshire coals of an illuminating power of 17 candles, and, secondly, to secure as large a volume of gas as possible of an illuminating power of 15 candles. The figures are too extensive to summarize; but just take, by way of example, those for Yorkshire coal. Here we get 12,059 cubic feet of 17·01-candle gas, and 14,236 cubic feet of 15·35-candle gas. The gross calorific power of the gas is 578 and 548 B.Th.U. respectively; and the total calorific value of the gas per ton of coal carbonized is 6,979,749 and 7,804,175 B.Th.U. The same applies to the figures for the other coals; showing that with the lower illuminating grade gas, there are a greater number of B.Th.U. for sale per ton than with the higher grade gas. The fuel account is shown to be very low. The sulphur for oxide-purified gas only is at a reasonable figure; and the naphthalene is low. The excellent figures (they are many) regarding residuals must be obtained by referring to the paper. In the analysis of the gas, the carbonic acid and nitrogen are low—especially the latter. An extremely interesting table is one illustrating how remarkably uniform are the quality and composition of the gas hour by hour; and another extraordinarily interesting feature are a couple of photo-micrographs showing the close texture of the coke from the vertical retorts as compared with that from horizontal retorts. The free carbon in the tar was shown by one test to be only 3·1 per cent. by weight, and in a second test 5·86 per cent., compared with 17·67 per cent. in tar from horizontal retorts. There are, it will be observed, many features of quite exceptional interest in this contribution.

Before Mr. Newbigging had quite finished the reading of the paper, an adjournment had to be made, as there was an appointment to keep with the Lord Provost, Bailie Paxton, and members of the Corporation and Gas Committee to lunch at the City Chambers, which function is noticed elsewhere. The carbonization question was taken up again next day. But meanwhile we may, to keep to something like a continuity of record in this review, refer to one or two other matters that occupied prior attention.

Surface Combustion.

In the evening, one could almost have imagined himself back again in the historic theatre of the Royal Institution, listening, as was the case a few weeks since, to Dr. W. A. Bone telling how far he has gone along the road with his investigations into surface combustion, and in the making, with the aid of associates, of practical application. The steam-boiler and the diaphragms for various heating purposes, the lantern pictures describing the applications to muffles and furnaces of all kinds, were there. There, too, were Dr. Bone and his assistants. The setting was the only thing

that was different. The Technical College of Glasgow is a fine building of comparatively modern times; the Royal Institution has ineffaceable associations with the greatest of scientific achievements and learned giants of the past. But though the setting was different, there was a large and interested audience in the body of the theatre and in the gallery—including several ladies.

Before noticing the features of the lecture, there are two or three points of interest about the fitting up of the place for it which the President had had carried out, under the supervision of his assistant (Mr. Walter Grafton). Very appropriately, the theatre was lit by one of those beautiful "Nonpareil" sun-burners that the President has invented. The one that was serving the purpose of illuminating the large hall consists of 28 inverted burners, arranged in a circle, each burning 2·8 cubic feet (about 80 cubic feet in the aggregate) per hour at low pressure. There has been a good experience with this type of burner in Glasgow; and it is found to work smoothly and certainly in operation. No globes are used with it. There is a development for shop lighting in rows of six closely spaced inverted burners—all lighted by one bye-pass. Though these lamps are fed by low-pressure gas, they give a very brilliant scintillating light. But there were other parts of the fitting up for the lecture that were of interest. There were Messrs. James Milne and Son's gas and air compressing plants. These are so positive in action that it was found that the pressures did not vary more than two-tenths of an inch. This was the plant that Dr. Bone used in his experiments—the compressor for the gas being equal to 1000 cubic feet per hour; and the air-compressor to 5000 cubic feet. The plant was driven by electricity, on account of there being no suitable gas-engine on the spot.

Dr. Bone's lecture was more experimental than anything else; being intended to demonstrate to practical men some of the results that have accrued from years of investigation. We heard again what is meant by surface combustion. As is now well known, it is primarily due to the accelerating influence of hot surfaces upon chemical changes in a gaseous system. From this point, we dived with Dr. Bone into the scientific and theoretical aspects of the fascinating subject. The main points were the same as were given in the Royal Institution lectures; and they are repeated in shortened form in the lecture delivered last week. Then came the demonstration of the realities of surface combustion. Flameless and perfect combustion was seen by the incandescent surfaces of the porous diaphragms. There was no doubt about it being realizable. There were also seen the high temperatures that can be obtained by the contact of flame in beds of granular refractory material. There were sceptics among the audience as to the utility of the system; but there it is. Its ultimate utility has yet to be worked out. Professor Bone, Mr. M'Court, and Mr. Wilson will not promise anything more than they are justified in doing by their experiments. They claim to have attained a higher and more uniform radiating efficiency from a surface of refractory material than has ever been attained before; they claim the possibility of attaining temperatures in muffles and other furnaces to a degree that is in excess of the heat-resisting capability of known refractory materials; and in a steam-boiler they claim a greater transference to the water of the calorific value of the gaseous fuel than has ever been realized previously in the use of gaseous fuel in this country.

A test made of one of the surface incandescent diaphragms during the lecture showed a temperature of 850° C.; an incandescent diaphragm was seen dipped into an atmosphere of carbon dioxide without any effect at all upon it—proving that the incandescent surface lays no claim upon the surrounding atmosphere. The improvement in the appearance of a surface by the application of a nickel gauze to the porous diaphragm was seen. Application of the system to the evaporation of liquids in the chemical and other industries was demonstrated; as was also the fact that the incandescent diaphragms can be used in the horizontal plane or at any angle. From this attention was directed to the furnace work; and ultimately to the application of the system to steam-raising in multitubular boilers. Incidentally, it was mentioned that, in the work so far done, there has been achieved a heat transmission to the water of nearly 95 per cent. of the energy represented by the net calorific value of the gas. It was explained how the waste products are utilized for feed-water heating. In one heat balance-sheet that was exhibited, it was seen that of 559,800 B.Th.U. supplied to the boiler, the heat transmitted was 527,800 B.Th.U.—representing an efficiency of 94·3 per cent. But for steam-raising purposes on the large scale, Dr. Bone rather thinks that, comparing the cost with coal, they will have to look for the gas to some form of ammonia-recovery producer-gas plant. The lecturer dealt with this question of cost at some length, as will be seen from the full report. One interesting point that he mentions is that there is now under construction a boiler, containing a hundred tubes, 4 feet long and 3 inches diameter. In a very few weeks, this boiler will be in use on blast-furnace gas. It will be interesting indeed to learn the results with this boiler.

There was an expression of interest and thanks to Dr. Bone not only from the United Kingdom but from the United States—Mr. H. L. Doherty moving a resolution, and Mr. Thomas Glover seconding it. Those present afterwards crowded round the temporary platform and lecture table on which the experiments had been carried out to witness a little demonstration of brazing by Mr. James Wilson in which the system is applied with a good economy in gas; and also to learn more about the rapidity of steam-raising by the new process. It was a thoroughly successful and interesting evening. The lecture itself was the subject of much after-conversation. Many of the practical men who had been present at it seem curious to know more about the utility of the process in comparison with other gaseous heating methods. Further revelation will come with time.

The Benevolent Fund.

A meeting of the subscribers to the Benevolent Fund was held on Wednesday morning, when it was gratifying to hear from the President that the subscriptions are coming in somewhat better than formerly—through, he considers, the efforts of the District Associations. But Mr. J. Ferguson Bell reminded that only 270 out of 843 members of the Institution were subscribers to the fund; and he says that there is urgent need for more subscriptions. Readers, who are non-subscribers, will note this, and act accordingly.

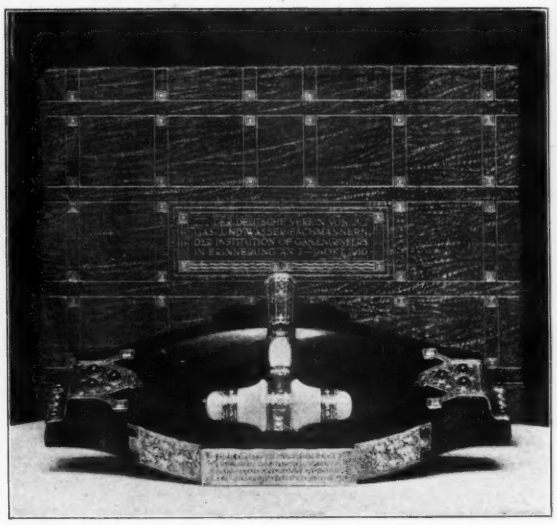
A Memento from Germany.

At the luncheon the preceding day, the Lord Provost had referred to a pleasing memento of the visit that members of the German Association paid to this country last October. It is in the form of an ornate hammer to be used by the President at the meetings of the Institution; and it was forwarded by the German Association to the President to transfer to the keeping of the Institution. The President now formally accepted the gift on behalf of the members; and cordial expressions accompanied the passing of a resolution recording the thanks and appreciation of the Institution to the German Association for the kindly feelings that prompted the gift.

The Selection of a Carbonizing System.

Then once more thoughts were turned to carbonization. The selection of a carbonizing system is one of the most difficult things facing a gas engineer at the present day when he has to consider reconstruction or extension work in connection with his retort plant. In the paper that followed (read in the absence of the author by the Hon. Secretary, Mr. S. Y. Shoubridge), Mr. Philip C. Holmes Hunt, the Chief Engineer of the Metropolitan Gas Company of Melbourne, lifted the veil, and took us into full confidence as to the questions that weighed with him in determining upon the system of carbonization that he should adopt for a new retort-house at the West Melbourne works. Points of view, of course, differ, as will be gathered from the other papers on carbonization and from the general discussion. But this must be said, whatever his point of view, Mr. Hunt was careful to a fault in awarding individual merit to the various systems. He was bound by the necessity of making a final selection without time for personal experiment in Melbourne; and having concluded that, for his class of coal, verticals were superior to horizontals, he had to have regard to the relative length of experiences; and, of course, the longer and larger experience has been obtained with the Dessau system. But that is only a point touching responsibility. The same system also forced itself upon his notice as being a thorough and finished one; and the manipulation is simplicity itself. It also offers a large amount of information as to gas make, residuals, and wear and tear. It lends itself, too, to working two eight-hour shifts, instead of three per day. The new type of setting

The "Chairman's Hammer," presented to the Institution by the German Association as a Memento of the Visit of Members to England and Scotland in October, 1910.



The Hammer and the Tapping-Plate, with Case (standing on its side) at Back, showing Lid and Inscription.

containing eighteen retorts is also regarded as a distinct advance on its predecessor. He could not find, among other points, that the question of pressure was any disability to those who had considerable experience of the system. There is passing reference to the Dempster retort-setting. On the point as to heavy or full charges, he fails to see how any new horizontal installation can compete in regard to cost of production with an installation of vertical retorts erected in strictly comparable manner.

And what of the continuous system? Mr. Hunt returned to Australia feeling that continuous carbonization is an ideal system of gas production; but he confesses that the completion of his observations left him somewhat disappointed. The development, in his opinion, leaves a good deal to be desired. Of the two systems—the Glover-West and the Woodall-Duckham—the latter is the only one aiming at continuous working [this surely requires a little explanation!]; and Mr. Hunt is forced to the conclusion that the automatic coal-feed in the latter could be advantageously superseded by the pressure feed system. He praises the ingenuity of the heating arrangements of the Glover-West system; and the work and ingenuity incorporated in the Woodall-Duckham system are also acknowledged. Both work without smoke, and both produce coke practically cold. But, in his circumstances, he cannot afford to judge the systems upon opinion, theory, or surmise. The Glasgow continuous-intermittent system has yet to prove its capacity of working with any class of coal. There are several references to chamber settings in the paper; but they may all be summed up by saying that they do not appeal to Mr. Hunt.

A difficulty experienced in making a selection at the present time is that what may be good to-day may be superseded to-morrow. But a certain risk has to be faced, by gauging the possibilities. Little progress would be made in abandoning the old ways for new if this were not so. Local conditions are naturally the leading points in coming to a decision—such as the character of the coal and labour charges. Points considered by Mr. Hunt were: Results, fuel account, conditions of working, area occupied by the settings, wear and tear, labour charges, and capital costs. Character of coal, of course, affects make. But he found that the average make from the Dessau installations visited was 12,900 cubic feet of gas of a calorific value of 577 B.Th.U. gross; from the installations of chamber ovens visited, 12,128 cubic feet of a calorific value of 567 B.Th.U. gross; while the average of heavy charge working in horizontals at works visited was 12,188 cubic feet of a calorific value of 520 B.Th.U. net. We are not told why the gross figure was not given for the horizontal working, so as to have made the comparisons uniform. Trials were instituted with a small quantity of Maitland (Australian) coal in the vertical retorts. In the Woodall-Duckham and the Glover-West retorts, results superior to those obtained from the carbonization of the same coal in horizontals, with full charges, were realized. But this coal makes very small coke in horizontals; and for largeness and hardness of coke, with a low proportion of small, using this coal, the Dessau verticals beat the continuous retorts. Mr. Hunt therefore came to the conclusion that, so long as the coal was left at rest during carbonization, the coke was much improved. The fluid residuals—tar and ammonia—were greater in quantity with the Dessau system than with full charges in horizontals. The absence of naphthalene, and the low percentage of sulphur compounds, also appealed to him.

To the Glover-West retorts, he awards the palm for heating and low fuel account; and with the intermittent system, he finds more smoke and steam than with the continuous. As to wear and tear, no definite figures were available with the continuous system; but at both Berlin and Cologne, he found the cost of repairs was working out to less than with horizontal retorts. The Woodall-Duckham system occupies less ground space per setting than the other two; but the minimum ground area required for dealing with 250 tons of coal per day is found with the Dessau 5-metre retorts. Again labour with the Dessau system, expressed in terms of tons of coal per man, takes the lead in economy. But the explanations made by Mr. Hunt on this matter must be read, because calculation is brought to bear upon the point. As to working and capital costs, he has ascertained that the annual savings with verticals on a 250-ton installation will amount to £1287, representing 12·87 per cent. on the additional capital outlay.

Summing up, the author feels there is reason to believe that, with the intermittent system, a rather higher sperm value can be obtained from the same coal; it offers a means of considerably improving the coke from the particular coal to be carbonized; and, further, the existing examples indicate that gas can be manufactured cheaper on a large scale by means of the intermittent retort in settings of eighteen than by means of the continuous retort. Another point claimed in favour of the intermittent system is the complete absence of machinery. Also Mr. Hunt regards steaming as being convenient and advantageous in dealing with a rich coal such as is available in Melbourne. Therefore, an installation of fifteen beds of eighteen vertical retorts is to be made at Melbourne. Nevertheless, Mr. Hunt does not want it to be concluded that he regards the Dessau system as the last word in carbonizing practice. The paper is a good one; and the case is put very clearly.

Discussion on the Carbonizing Papers.

Before the discussion commenced, the President made the interesting remark that this was the first paper that the Institution has received from our dominions beyond the seas; and he hopes that it will only be the first of many more. The Hon. Secretary also threw in a word of testimony as to the extraordinary care that Mr. Hunt took in his visit home and to Europe to form a correct judgment before adopting a vertical system suitable to his purpose, and to obtain accurate results. But turning to the papers generally, it was pretty obvious that the members felt, by the time they had reached the end of the fourth contribution on the subject, that they had been surfeited by it, and that they hardly knew where they were. It was only those who had made a special study of the papers who could extract the essentials; and it is feared that, for the most part, it was

only those who are directly interested who had taken the trouble to critically examine the papers comparatively. As a matter of fact, there had been too much of the papers, and too little time left for the discussion of the subject. Both facts were a clear discouragement to discussion; and it cannot be said that the papers or the discussion, in the result, have done very much for those among us who are "sitting on the fence," and are seeking aid. Facts there were in abundance; and we are not altogether sure that there is agreement with Mr. Edward Allen that more facts on the subject are wanted. It is the co-ordination of the statement of the facts that is much required. Mr. Allen summed up the position epigrammatically and well when he said that Mr. Drury's paper was characterized by carefulness, Mr. Leather's by candour, and Mr. Newbigging's by enthusiasm. Mr. Hunt was complimented for the excellent manner in which he submits the grounds for his adoption of the Dessau system. The sum and substance of Mr. Allen's remarks was that each system claims several things; and that there is plenty of material in the papers that would not pass unchallenged. There was one point in particular that Mr. Allen fastened upon. It was that, when Mr. Newbigging was making 15·5-candle gas—such emphasis was laid by Mr. Allen upon the statement that this was as tested by the No. 2 burner that the members laughed, in some quarters, rather heartily—he obtained more B.Th.U. per ton of coal carbonized than when making a rich gas.

In addition to Mr. Allen, Dr. W. B. Davidson, Mr. J. C. Belton, Mr. Thomas Glover, Mr. J. W. Broadhead, Mr. J. Ferguson Bell, Mr. H. L. Doherty, Mr. Samuel Glover, Mr. P. G. Moon, Mr. John West, and Mr. Charles Hunt engaged in variable degree in the discussion. This ranged over many points; and it was terribly partisan. There was considerable criticism of the fact that the bases of the capital costs of Sunderland and Droylsden do not agree, and that Mr. Leather had left the matter entirely out of his paper. In his case the fact that the retort-house was built for horizontals or inclines makes a difference. There was an attempt to remedy the omissions. Mr. Moon referring to the Woodall-Duckham system instanced, in order to supply a comparable figure, that, including coal and coke handling plant, retort-house and bench, excepting foundations, the figure might be taken to be about £184 per ton of coal. Mr. Drury, too, says that the adding of the foundations in his case would only mean increasing the cost to £184 per ton. Labour costs also claimed much attention. What does the figure given include? asked several of the members. Whatever the components, the figure per ton is getting very low. Mr. T. Glover points out that his Norwich figure with horizontals is down to 6·97d., as against Sunderland 7·25d., while Droylsden is down to 4·2d. Mr. Charles Hunt explains that the figure given by Mr. Drury is for the Dessau system in its original form. It has been considerably improved; and now, with eighteen retorts in a setting, and the charging and discharging going on with three retorts simultaneously, the costs per ton have been reduced to about one-half. Mr. Drury also contends that to the Droylsden figure the cost of the gas used for driving the extractor, and the cost of upkeep of machinery, should be added to the labour costs.

The feeling of the meeting was not entirely on the side of the continuous or on that of the intermittent system. It is considered, for example, that Mr. Philip Hunt has proved that local conditions, such as those of labour and coke requirements, should receive consideration before arriving at a decision one way or the other. Mr. Broadhead appeared to be promising that before long the Cleethorpes installation of Dempster intermittents will satisfy that this type does not possess certain of the disadvantages somewhat freely ascribed to the system generally. The results he quoted are certainly worthy of close attention. On the other hand, it is pretty clear that those who are of opinion that intermittent working is not so scientific as continuous, are not satisfied that Mr. Hunt does justice to the accrued experience with continuous carbonization.

When we come to results, the first notable point that the intermittent adherents have to swallow is that Mr. Leather hopes before long to show that there is a considerable difference between the composition of gas from continuous and that from intermittent working. The horizontal champions hold that the vertical men should make their comparisons between verticals and the best of horizontal settings and workings. Then, argue some, there is nothing much to choose between them. Of course, the character of the coal carbonized has a great deal to do with results and Mr. S. Glover, with glowing enthusiasm, maintains that the best that can be done with any given coal in horizontals can be exceeded by its treatment in continuous vertical retorts constructed on a right system. He quotes some handsome figures from the latest installation at St. Helens. But, generally speaking, in the various figures published, there are such divergencies in the working that produced them that, for comparative purposes, their value is very sadly diminished. Again, others see evidences of economy in the vertical retort, and which economy will be increased with experience. There are the wear and tear, fuel (less, it appears, in the Glover-West system than in any other), lowered sulphur and naphthalene content, better coke, and more ammonia and tar. In making a low illuminating quality of gas, it was shown that there is an advantage in the vertical system. While mentioning this, it is interesting to remark what Mr. Moon says as to the Lausanne figures in Mr. Leather's paper (he also gave some additional ones) that they come from a gas-works where, as at Ayres Quay with the Dessau system and Droylsden with the Glover-West settings, there is no other carbonizing plant than Woodall-Duckham verticals. On the subject of fuel, some experiments have been made at Norwich to ascertain the loss of heat units by the withdrawal of the incandescent coke from retorts. It is found to be equal to about 2 per cent. on the fuel, the relation of which fact led Mr. T. Glover to point out that the Glover-West continuous vertical retort lends itself to a great conservation of heat, and hence economy of fuel.

Coke also received considerable attention in the discussion. Mr. Doherty is afraid that the continuous system would be regarded in America as likely to produce a coke containing many fissures. It should not be overlooked, however, that the coal put into a continuous vertical is not converted into coke directly it enters. The volatile matter is only gradually distilled out of it, so that it is hardly in a condition to be adversely injured for any distance of its slow travel in the retort. Another point. As Mr. Moon remarks, we do not in all places want metallurgical coke. Coke is required with a low ignition temperature point for domestic use; and continuous retorts are, he holds, capable of making this in the best possible manner.

There is one matter that must not be overlooked. Mr. Bell has established a reputation for a strenuous advocacy of the heavy charge in the horizontal retort. He sees nothing in the vertical retort now for justifying the premature scrapping of horizontals; but the test of Derbyshire coal at Sunderland has convinced him that verticals are worth consideration. For his reasons, reference must be made to the full report. But the prominent fact is that Mr. Bell has been converted.

Meeting of Joint Commercial Sections.

There was barely an hour left between the long morning sitting and the meeting of the Joint Commercial Sections in the afternoon; and we are afraid that this had a detrimental effect on the attendance, and naturally upon the discussions. Among other subjects that engaged attention was an informal appeal for support of the propaganda work of the Sulphate of Ammonia Committee by those concerns that have not yet become subscribers, whether or not makers of sulphate of ammonia. The question of the education and certification of gas-fitters was also discussed. The upshot was that the matter is to be referred to the District Associations for consideration and report to the Manchester District Institution. A scheme will then be redrafted, and submitted to the Institution for consideration.

High-Pressure Gas for Industrial Purposes.

Though the services of Mr. E. W. Smith, M.Sc., have been lost to the gas industry in connection with the gas-heating research work at the Leeds University, his energies and talents are being devoted to the development of new lines and means of applying high-pressure gas in connection with the Birmingham Corporation Gas Department; and the acknowledgments of the industry are due to the Gas Committee for so freely permitting the experiences gained being transmitted from time to time, in one form or another, to the industry for the general behoof.

The paper which Mr. Smith presented on the subject, and of which he commenced the proceedings on Thursday morning by giving a *précis*, was a compendious account of the investigation and progress so far achieved in utilizing high-pressure gas for manufacturing purposes in the greatest

of Midland centres of industry, where there is opening for varied application probably unrivalled by any other industrial city or town. Mr. Smith modestly disclaims that his object in reading the paper is to teach; and he wants it to be understood that he is not dogmatizing in any way in giving an unvarnished tale of what his research and experience have to this stage led him to select as best for the circumstances with which he has to deal. His standpoint is summed up in the words: "The whole subject is comparatively new; and much of the foundation has still to be built." The highest efficiency in gas-heated appliances is the aim of his work; and "efficiency" here comprehends that all-important feature in industry, works' economy. Where low temperatures are required, with high-pressure gas, natural draught, or air blast, it is possible to attain the requisite conditions with a high degree of efficiency in a properly designed furnace, though with high-pressure gas more even results are possible. Where high temperatures or large quantities of heat are requisite, air blast and low pressure gas and high-pressure gas have a much wider range of manipulation than natural draught. The disadvantage of furnaces heated by low-pressure gas and air blast, however, is that the efficiency depends on the two pressures remaining constant.

Taking up high-pressure furnace heating, Mr. Smith found that a furnace burner satisfactory to him was not available; and he designed one in which the jet plays into a correctly shaped and dimensioned conical hole, which is part of the burner itself. The tube holding the jet is made adjustable —moving to or from the cone—so that the volume of air carried into the furnace is regulated. The arrangement of the burners is another important point, and so is the cubic capacity and design of the space in which the combustion is completed, as well as the refractory materials used. The amount of the combustion space, again, varies with the specific heat of the metal to be melted, and the temperature to be attained. In no high-pressure furnace is there any appearance of flame either at the burner or in the furnace itself. The newer furnaces are being constructed with a double circular lining, consisting of the best standard sized arch fire-bricks, in order that, when the inner one is no longer fit for use, and past repair, it may be quickly replaced by another. It is interesting to learn that all metals with melting-points up to 1400° C. are being melted on a commercial scale; and the cost of doing so compares favourably, in by far the majority of cases, with coke-heated furnaces if only in fuel alone. Time and previous loss savings have also to be reckoned in the economy of the factory. In the heating of liquids, too, high-pressure gas has proved its advantage over low-pressure gas.

Then Mr. Smith allowed his interested audience to revel in the results of comparative tests in proof of his assertions; and next he described the foundry and plant associated with the high-pressure section of the Birmingham Gas Department—valuable comments being made on the different types of plant and the fittings. Steam piping is preferred for the services; and, on that ticklish subject the measurement of high-pressure gas, Mr. Smith expounds instructively. Incidentally he does not believe that any device will be permanently satisfactory which automatically corrects the reading of the meter with changes in pressure. The forms of high-pressure gas blowpipe adopted in Birmingham are described; and then information follows regarding the melting of gold alloy and aluminium and its alloys. One of the concluding statements is that, with gas at from 1s. 3d. to 1s. 6d. per 1000 cubic feet, there should be a great future for gas in industrial service. It can be applied to all heating processes, with efficiencies reaching in some cases at least 90 per cent. Its chief charm is its cleanliness and its simplicity. The paper is full of point for those entering into this particular business.

As remarked above, Mr. Smith, instead of reading the paper, thoughtfully gave a *précis* of it. Among asides, he alluded to the consumption pressure curve given in the diagram accompanying the paper. This, it should be particularly observed, is quite correct for Birmingham gas; but it would vary as the specific gravity of the gas for different towns. One other point that Mr. Smith makes is that he does not think that tables giving costs of melting various metals should be published, inasmuch as very slight variations in the state of the metals or other conditions may make considerable differences in the figures. There was, in the discussion, recognition by the President and by Mr. J. F. Bell of the enterprise of the Birmingham Corporation Gas Department in this pioneer work; and every credit was accorded the Committee for their kindness in allowing to be published the results of the work that is being done in the high-pressure section. One case of industrial heating in which Mr. Bell is concerned at the present time is that of brass melting; and he makes the point that bare cost of fuel is not the only thing to take into consideration. There are the savings in crucibles and materials to be included in the reckoning. There were criticisms of various points in the paper by Mr. Leather; but one strong stand he takes is that he does not believe in surface combustion at all. There would have been additional interest had a discussion been permissible after Dr. Bone's lecture on Tuesday evening, as there is no question that Mr. Leather is longing to join issue with him. He is well aware that certain experiments have shown the influence of surfaces in promoting combustion; but he questions the theory, more particularly in regard to high-temperature furnaces. Old advocate as he is of high-pressure gas supply, Mr. George Helps is of opinion that this high-pressure business can be carried too far. His opinion is that a pressure of 100 lbs. may be carried in mains; but for most purposes a governing-down to 3 inches will give consumers all they want. He sees, too, very little use for high-pressure meters; and at Nuneaton a governor is used that answers all purposes. With the high quality gas in Glasgow—at (say) 60 to 80 inches pressure—the President has difficulty in obtaining a proper admixture of gas and air. But if a little air is put into the gas, and sent forward with it, a better efficiency in the mixture is realized. In his reply, Mr. Smith was brief, in keeping with the discussion. He refused, in Dr. Bone's absence, to be drawn into any discussion of surface combustion. He responded, however, to the series of criticisms by Mr. Leather and Mr. Helps. On the more general questions, he states that in Birmingham there have been bursts with low-pressure meters; and therefore it has been found necessary to have high-pressure ones. Naturally he is glad to know that Nuneaton has an efficient governor.

Public Lighting.

This is a subject that was handled in the succeeding paper by Mr. S. B. Langlands, who as the chief of the public lighting department of Glasgow considered—and rightly—that the members would be interested in hearing some particulars of how the work of his department is conducted. There is this to be said, that it is a very proper thing where gas and electricity undertakings are administered by a municipal body that the public lighting should be under an independent Committee, and that the department should have as its executive head a progressive expert in the matters with which it has to deal. Glasgow has such an expert; but it is not the case in all towns. We have come across instances where the "expert" clings to those things that were in the days of his youth, with a tenacity that results in disgrace both to himself and to his town. The singular thing is he does not realize it. More is the pity. But these remarks do not apply to Glasgow. There is a fair number of flat-flame burners still in the by-ways, the courts, and on the common stairs of the city. But that is not the fault of the technical chief of the lighting department. It is mainly due to a combination of circumstances in which an Act of Parliament limits to a very low maximum sum per annum the payment to be made by owners for flat-flame burners of modest consumption. But diplomacy is gradually making its impression, and is pushing in a suitable inverted incandescent burner —the "Glasgow," the design of which is the product of the President. The city is lighted by 873 electric arc lamps (only 36 of which are Osrams), and 16,740 incandescent gas-lamps. In the private streets and courts, there are 2287 incandescent gas-burners, and 3524 flat-flame burners. In the closes and on the common stairs throughout the city's tenements, there are 19,763 incandescent gas-burners, 2178 electric stair lights, and 45,045 rat-tail jet gas-burners.

There is a change coming over the character of the bargain between the Watching and Lighting Committee and the Gas Department. The latter will in time be supplying light at a certain cost for street illumination. At present the Watching and Lighting Committee buy 425 million cubic feet of gas from the department, and do with it the best they can. The Electricity Committee supply lighting —charging so much for lamps of defined illuminating value. The Gas Department are about to erect 50 high-pressure gas-lamps; and the Electricity Department are going to change the arc lamps to the flame arc type. Comparative

data of up-to-date systems will thus be afforded which will be of immense value. In this way, the conversion of the old style lighting will be going on at one end, and progress will be in the making at the other end. At the same time, Mr. Langlands retains a partiality for well-maintained low-pressure lamps and close spacing. With staggered placing, there is seldom more than 30 yards between the low-pressure lamps in the city. Only in the outskirts of the city does the spacing run up to 50 yards. Kern burners are the ones used; and each lamplighter is given 120 lamps for which he is solely responsible—including lighting and extinguishing, cleaning, and maintenance generally. Mantles are all stamped; and the surveyors keep the lamps under observation and report defects. The policy followed is not to save mantles, but to light the city. Last year the high rate of 9·16 mantles per burner resulted. Inverted burners are being experimented with. For them the square lantern is preferred rather than the bowl. We like the appearance of the latter better, though square lanterns are easy of repair. Volumetric governors are used with the upright burners; but they are not favoured by Mr. Langlands. Pressure governors are being tested with inverted lights. As to mechanical or pressure control of the street-lamps, he believes that a system of electrical or clockwork control will in future prevail. Mr. Langlands gives information as to the methods pursued by his department. Later he expresses the view that a standard specification for street lighting will be useful. Following this, he emphasizes the importance of street lighting from the advertising point of view, and then refers to the value of a testing-station in connection with a public lighting department. The paper is brimful of practical points from an extended experience.

Again the discussion was not of great length; but Mr. Langlands found friendly critics before he had finished. The speakers included Mr. Bernard F. Browne, Mr. A. Yuill, Mr. W. J. Liberty, Mr. George Helps, Mr. Walter Grafton, Mr. E. A. Harman, and Mr. Edward Allen. Glasgow was complimented on the one hand for the upkeep of its lamps, but criticized a bit over the fact that it is hanging-back somewhat in the matter of applying high-pressure lighting and inverted burners. Mr. Liberty was especially strong on this point; and he related the history of progress as illustrated by the City of London. Mr. George Helps also thinks there is good opportunity for high-pressure lighting in Glasgow. Gentle reproof was administered by Mr. Allen for what appeared to be a doubt, expressed in passing by Mr. Langlands, as to 60 candles per cubic foot being obtained with high-pressure gas-lamps. He himself has realized 60 candles in Liverpool; and he sees no reason why in other places 70 candles may not have been already reached. Mr. Walter Grafton, the President's Assistant, made a special point of the fact that there is a distinction between the Glasgow coal gas and the gas of the South, which makes a difference in the specific gravity and in the respective volumes of air induced by vertical and upright burners. He gave what was quite a neat little dissertation on the point. An incidental suggestion that he makes is that gas might be sold for public lighting under a pressure sliding-scale. Mr. Langlands finds that with vertical burners he can get 18 candles per cubic foot of gas used; while with inverteds he is only able to realize 21 candles—a gain of merely 3 candles. What about the distribution of the light? Good street lighting has a strong advocate in Mr. Yuill, who thinks that it is the best answer to the complaints of private consumers. The interesting point was brought out by the same gentleman that there is a difference of lighting hours between Scotland and the South. In the winter time, it is no uncommon thing to light up at 3.30 in the afternoon, and not extinguish until 8 o'clock in the morning. But when we learn from Mr. Langlands that the lighting hours in Glasgow are 3780 per annum, the figure does not strike us as extraordinary, seeing that in London we talk usually of about 4000 hours. The question of automatic lighting was also dealt with by Mr. Yuill. He is not in favour of pressure-wave lighting and extinguishing for Dundee with its irregular configuration. A failure with the system may apply universally over the street lighting; a clockwork controller only means a unit failure. That is one view. There are other points for consideration. The official work of the author was praised by the President. Mr. Langlands made good his position by pointing out that, before effecting further changes in the public lighting, his idea has been to perfect the administration and improve the present lighting system.

Effects of Modernization.

It does not require argument to persuade the average man that modernization of plant, appliances, and methods pays. The average man knows it; but, for unaccountable reasons, the man who is fully convinced of this is sometimes the slowest to move in bringing about the desirable condition. Mr. C. F. Broadhead tells us, in the paper that he was called upon by the President to read, of what he has succeeded in doing at Middleton. He had a somewhat depressing tale to bring before the members of what he found there a few years since. A heavy capital account, with a comparatively low output of gas. Losses were being made; the reserve fund had no substance; and the production of gas and the sale per ton of coal were not such as one could go into raptures over. We congratulate Mr. Broadhead and the Gas Committee of the Middleton Corporation upon their wisdom in going about the work of rehabilitation in a thorough manner. In illustration, the old defects in the inclined retort-settings could only be met by complete reconstruction—in which the keynote was simplicity.

Mr. Broadhead opens to view several pages of his practices at Middleton; and here and there he drops from the direct course of the story, and gives us his views on various topics of the day in the gas industry. For example, he shows he has a very healthy opinion of heavier charges and longer duration coal carbonization; and although, through described circumstances, he has not yet been able to determine the matter precisely, he thinks that for inclined retorts —having regard to make per ton, production per mouthpiece, and calorific and candle power—a 10-cwt. charge of eight hours' duration seems of the greatest all-round benefit. The gas make per ton at Middleton last year was 11,502 cubic feet. About five years ago it was only 9900 cubic feet. The consumption of cannel has been reduced from 11 per cent. to *nil*, and benzol enrichment has been abolished. There is a material and creditable economy in all this. The aim now is a carbonization of 12 tons of coal per bed per day, a make of 12,000 cubic feet of gas per ton, with a net calorific value of 525 B.Th.U., using coal costing at the moment 12s. per ton. This has already been attained on the summer make. The fact is plainly traced that continuous carbonization in vertical retorts has found favour in Mr. Broadhead's eyes; and we shall expect to hear that the half of the retort-house roof that is now being raised at his works will, in due season, be sheltering verticals.

Passing to other features of the paper, it is ascertained that Mr. Broadhead believes in handling coke in bulk. The old coke-handling plant has already had its day. The elevator has been displaced by a 20-feet steam-hoist, which raises coke and waggons on to a gantry, by means of which the coke is deposited in hoppers or on to the coke-stack. A vertical condenser, a new exhauster, and retort-house governors have been installed. It is a satisfaction to learn that there has been no trace of naphthalene whatever since the introduction of heavier charges, more gradual cooling conditions, and a lower candle power. A new boiler, a Livesey washer, and a twin scrubber have been put in; and a rotary scrubber is being overhauled and fitted with bundles. The use of lime has been abandoned. Where the boxes stood, a new sulphate of ammonia plant has been installed. The oxide boxes were originally filled with ordinary grids, and had a capacity of 40 tons, while with the hurdle grids of to-day the capacity is 50 tons. A wrecked gasholder has been cleared out of a 60-feet tank; and a small three-lift spiral holder has been erected in it—increasing the storage capacity of the works by some 125,000 cubic feet. There is also a proposal for replacing a two-lift column-guided holder by a three-lift spiral one.

Mr. Broadhead in more general statements mentions the fact that the Corporation obtained last year a change of test-burner to the "Metropolitan" No. 2; and a reduction of the prescribed illuminating power from 18 to 14 candles. Powers were also obtained to inspect, supervise, supply, and maintain consumers' fittings and appliances. He regards the publicity scheme as a sound business proposition; and he turns from this to dilate on the need of uniformity in pressures and calorific values. He thinks that in new districts high-pressure steel mains and governors will become the practice in distribution. The abolition of cooker-rents in Middleton has given an impetus to the use of cookers; and the maintenance of consumers' fittings has become an accomplished fact. But the excellence of the policy is all summed up without going further into the paper in the fact

that, in the first half of the past decade, the total net loss on the undertaking was £4400; while the second has resulted in a net surplus of £11,000. The reserve fund has begun to accumulate—being now equal to 3 per cent. Cooker and meter rents have been discontinued, and the price of gas is to be substantially reduced to both ordinary and prepayment consumers. There is in these facts all the justification for the modernization that has taken place; and there the paper may be left, without having to discuss the controversial point as to differential prices, except to say that differential prices are not to-day a matter in which sentiment can have part. The competitive value of gas for any purpose must weigh in the determination of the question.

There will not be much interest in reviewing the discussion, as Mr. Broadhead is going to answer it in writing; and furthermore there were few general points—the speakers grasping several and various details for criticism and comment. This does not help to concise presentment. Among the speakers were Mr. C. F. Botley, Mr. G. M. Gill, Mr. Harold Bloor, Mr. G. Helps, Mr. T. Canning, and Mr. H. Kendrick. Mr. Botley does not believe, though it may be an ideal system in some cases, in having an inclusive price for gas—that is to say, including the meter—seeing that there are electricity consumers who have gas-meters as stand-bys. The varied points laid hold of by the speakers suggest the applicability of the truism that what is suitable for one works or undertaking is not always suitable for another. On the point of the commendation of the Publicity Committee's work by Mr. Broadhead, Mr. G. Helps was curious as to whether that gentleman had sent along the cheque representing the subscription of his undertaking to the Committee. Mr. Helps has not done so as yet from Nuneaton, but hopes a few days' time will see the omission rectified. The important subject of the qualification of gas-fitters was touched upon by Mr. Kendrick, who holds that it is no use registering such workmen unless the qualifications of each are known. On the subject of the letting out of cookers, he says that it is found in his district that the portion of a cooker that is used most frequently is the hot-plate. Therefore, in the Manchester district, many under takings send out grillers instead of cookers; and they find the average consumption equal to that of the latter. The applicability of this we should imagine, depends on the character of the district. Nevertheless, the outlay in the case of the gas undertakings following this system is less; the return, greater. The same speaker believes in differential prices, especially for daylight gas.

Corrosion of Service-Pipes.

It is a truism as old as the hills that large advantages cannot be secured without their being discounted by disadvantage in some shape or another. Now we have, in the paper which the members were next privileged to hear, Mr. James M'Leod, of Greenock, telling us that the price that is being paid for the advantages that accrue from the new methods of carbonization include that of the more rapid corrosion of service-pipes; and he makes out a very good case in support of his theories. Incidentally, he treats with little mercy some of the explanations regarding corrosion that have been advanced in times gone by. We have been taught, among other things, to believe that the "acidiferous" nature of soil surrounding services, more especially where the soil contains ashes and refuse, has a strongly corrosive action on pipes. But Mr. M'Leod has never met with a sample of ashes or ashpit liquor that was not strongly alkaline. Alkalies generally prevent the corrosion of iron, possibly by taking up any carbonic acid present. His view is that where ashes are present, the greater porosity of the soil permits access of air and moisture containing carbonic acid, which is not always absorbed by the alkali of ashes. But it is not submitted that this covers every case.

There is no doubt that Mr. M'Leod distinctly suspects the changed methods in carbonization and purification of contributing to the more rapid corrosion of service-pipes—that is to say, the employment of higher temperatures in carbonization, the sole use of oxide for purification with revivification *in situ*, and also, and possibly not least of all, the abandonment to a large extent of cannel coals of all qualities in the desire to produce a really good gas coke, and a gas that is suitable for present-day requirements. He does not say that these things should not be; but the more rapid corrosion of the service-pipes is one of the penalties that have to be paid for them. Increased temperatures, under the ordinary systems of coal carbonization, mean additional amounts of carbonic acid, sulphuretted hydrogen, carbon disulphide, and cyanogen; and, with the possible exception of carbon disulphide, all these bodies may be an aid to corrosion. [Mr. M'Leod has evidently not examined this point in relation to vertical-retort working.] The increased temperatures also mean a decreased amount of oily matter for deposition as a protective coating on the inner surfaces of the service-pipes. Mr. M'Leod discusses all these points, enlarging upon the influence on the corrosion of pipes of the greater amount of gaseous impurities produced by higher carbonization heats, of the retention of all the carbonic acid in the gas by having recourse to oxide only in purification, and of the slightly increased percentage of oxygen available in the gas for the formation of oxide of iron or rust through revivification *in situ*. The abandonment of cannel coals has resulted in a lowering of the percentage of illuminating hydrocarbons in the gas; and there is consequently less chance, as already said, of the formation of a thin protective coating of oily deposit on the pipes. Mr. M'Leod holds out no cure, but suggests that service-pipes of the best steam quality might be used, and the life of services thereby lengthened and troubles lessened. These are only some of the points in a paper that is good, and full of pithy matter.

A feeling had spread through the meeting by this time that there had been sufficient business of a technical nature, however interesting. There had been a considerable thinning-off of the members who were present at the beginning of the morning's work. However, there were two or three interesting points in the few comments passed upon the paper. Mr. Vass had occasion to bear witness to the fact that latter-day service-pipes appear to give more trouble than earlier ones; and he agrees that this is due to the reduction of the hydrocarbons in the gas. Where gas can be kept clear of traces of sulphuretted hydrogen and moisture, it is possible to keep free of this trouble. He fancied that Mr. M'Leod had arrived at the conclusion that there is no remedy for the trouble; but Mr. M'Leod himself points to a remedy. If the moisture of the gas is reduced before going into the mains, there will not be much trouble. Mr. Samuel Glover made due acknowledgment of the value of the paper. There was a protest from Mr. M'Leod against any one taking what he had said as an admission on his part that there is no remedy for the condition of things as described by him. The use of oil alone will prevent the corrosion of service-pipes.

Gas Supply in a South American City.

The members settled down to hear from the lips of Mr. Bernard F. Browne, not long since returned from Buenos Ayres, an account of his experiences in the management of a gas undertaking in that city. It was the final communication; and he had to epitomize it—with tremendous sacrifice to its good points. However, the paper led the members from the comparative quiet of their own environment into a condition of affairs that is far more strenuous. If a gas engineer and manager at home finds his circumstances too humdrum for his super-active nature, then, if he can find a berth, let him hie himself off to Argentina or some other part of South America. Labour appears to be at the bottom of all the uncertainties of the gas engineer in Argentina so far as his works are concerned. He has to deal with a class of labour that is migratory, erratic, and susceptible to agitation and intimidation; and it goes against the even tenor of manufacturing operations when the tuition of fresh men is the rule and not the exception. The same with the district men. When these things are considered, it accounts for many of the suggestions that Mr. Browne puts forward that he found efficacious, under the circumstances, and some of which are unnecessary in this country. Commercially, the main difficulties of the gas industry in the distant city of which he speaks are found in the facts that, in lighting, the tariffs of gas and electricity are on practically equal terms, and, in a tropical country, the heat generated by the incandescent burner is not a recommendation—more especially when the electricity purveyors refuse to supply current at power prices for ventilating-fans unless current is also taken for lighting.

From these points, the author passed to the consideration of drawbacks that bear on the trading in gas. The freights for coal undergo violent fluctuations. In some years, they appear to be more per ton than the coal itself costs. The result is that, when freights are low, large stocks have to be placed upon the works, and then there is the difficulty of spontaneous combustion so common with sea-borne coal.

For various reasons, machinery for handling coal and coke, as we know it, appears to be little used in Argentina; and the man with the barrow requires a deal of looking after. This being so, a comparatively modest system of lightening labour —simply a continuous system of "slung" joists, carrying a tip-bucket on a ball-bearing carriage—is used.

Coming to manufacture, the method is explained of how good carbonizing heats are maintained; and there is a reference to certain disturbing factors, and how they are remedied. These matters could only be described in the words employed by Mr. Browne; and so we pass on. For the safe-guarding of retort-house governors, it is found convenient to have an automatic valve in the foul main between the governor and the hydraulic. In connection with steam production with waste gases and automatic water-feed, the difficulty of water-feed is absolutely eliminated by the use of a safety feed-water regulator, which automatically maintains a water-level within a limit of 1 inch. Among many "wrinkles," Mr. Browne describes how carborundum is of considerable efficacy on new work in prolonging the life of combustion chambers and producer linings. He applies three coats of a solution composed of 75 per cent. of carborundum powder and 25 per cent. of water glass as a carrier, diluted as required with water. Among other strange practices, is the reserving of all retort carbon for gas-making purposes; and, as a constant preparation for labour troubles, a considerable quantity is kept bagged on the operating-stage of the water-gas plant. In time of labour difficulty, its great advantage is the absolute absence of clinker in its combustion, and the feasibility of working for a week if necessary on this fuel without cleaning the fire. But with it the blast pressure has to be reduced. There is an account of the utility of cycle recorders for positive and negative pressures; and the advantage of employing a portable vacuum chamber for emptying syphons and kindred purposes is described.

In the disposal of coke, the want of accommodation in even modern dwellings led to the satisfactory development of a coupon system. Cheques of ten coupons are sold in the branch offices; and the coke distributor on his weekly call exchanges bags of coke for an equivalent number of coupons. The growth of the business necessitated the introduction of the card system in the coke office. How the pumping of tar long distances by high pressure produced trouble, and how the trouble was successfully eliminated, is explained; and not the least interesting and valuable section of the communication, in these days of the use of tar for road surfacing, will be found in the information imparted as to the dehydration of tar.

The gas-works, owing to distance from Europe and high import duty, have to be largely self-reliant in the matter of repairs, erection, and even the making of plant with which it is possible to cope; and the manufacture of meters and cookers has also to be undertaken. In dealing with the distribution department, the utility of return (2-inch wrought iron) pressure-pipes in maintaining good pressures is proved. Meter methods receive much attention; and, in this connection, it is learned that a considerable discount is allowed on all gas used as fuel—rotary discount meters being employed in series with the main supply meter. Thousands of this type of meter are in use for this purpose with satisfactory results. Great value is attached to giving systematic attention to consumers. In placing cookers, geysers, and stoves, Mr. Browne found the hire-purchase system the best; and no diminution in the volume of trade followed its application. The total cost is divided into thirty monthly payments. A travelling cooker-cleaning gang is another novelty; the consumer paying a small monthly charge for the service. For kitchens with limited accommodation, Mr. Browne produced a combined coal and gas-cooker range; and for occupiers who objected to the direct gas-flame method in the oven, the grate was modified so as to take gas-heated ball fuel. The step to combination fittings for gas and electric lighting was a short one. To cover burner maintenance, an inclusive price of 6d. extra per 1000 cubic feet is charged, with a minimum of 1s. 3d. per month. Installation work is also undertaken. Following all this is an account of the business methods adopted; and they are varied. One good thing is the distribution of a gas almanac with the new year —the front of the date-block being in the form of a post-card, and on the reverse side a suitable formula to enable a consumer, with little trouble to himself, to denounce to the Company any defect in his supply or installation, or to solicit the attendance of an inspector. All this costs money; but in the concluding lines of his voluminous paper, Mr. Browne shows that it all paid in the expansion of business despite the then existing competition—both gas and electric. More than ordinary interest is found in every line of the paper, and novelty in many parts.

At the close of a hastily-delivered summary of the paper, complimentary remarks, practically nothing else, fell from Mr. Samuel Glover, Mr. F. J. Bywater, Mr. F. W. Cross, Mr. C. F. Botley, and Mr. E. A. Harman. The last-named gentleman said he is now selling 12 lbs. of coke in bags for 1d.; and thousands of such bags are disposed of in Huddersfield. This bag system of selling coke did not, Mr. Browne says, take on in Buenos Ayres. The people are "great" on lottery tickets there; and consequently the coupons that he adopted for sales of coke, being beautifully lithographed, "took on" wonderfully well.

The New President and Place of Next Meeting.

The technical work concluded, there was business of a pleasing character still to perform. The Presidents of the Société Technique du Gaz and the German Association were elected Honorary Members. Then there was a perfect shower of votes of thanks. All the hosts in Glasgow—all who had taken part in making the meeting the magnificent success it had been—were thanked, and that right cordially. The President and Mrs. Wilson were included; and there was much cheering—it was a proud and at the same time a disconcerting moment for him—as the President rose to express his acknowledgments. Every officer of the Institution and member of the Council who had served during the past year was also thanked. The President-Elect responded for them. He made a significant remark. The work of the Institution has grown so much that he thinks the Council will have to be before long divided up into water-tight compartments. This is one way in which there will possibly have to be development, quite apart from the question of the broadening of the basis of the organization. There was a suggestion made by Mr. A. E. Broadberry, which, if adopted, would be useful. He did it in responding to an "omnibus" vote of thanks to committees, authors of papers, &c. It was that a synopsis of the papers should be prepared, circulated, and published prior to the annual meeting.

Then came the report of the Scrutineers. The announcement that Mr. R. G. Shadbolt had been elected to the presidency was received with much applause. Mr. Shadbolt found, as he always does, suitable expressions for the occasion. One point he raised in his remarks was that those who were anticipating election to the highest offices in the Institution should not be kept on the "gridiron" for a couple of days at least after the Scrutineers had completed their examination of the ballot papers. He thought that in future the result might be posted up as soon as it was reached. Mr. Edward Allen now joins Mr. Bell in the vice-presidency; and the announcement was heartily greeted by the members. After a brief discussion, it was agreed that the next meeting should be held in London.

"This brings us to the end of a most successful meeting," remarked the President; and the plain words inadequately mirror the truth that the Glasgow meeting of 1911 will stand conspicuous for success in the annals of the Institution. All who made it so have placed the members and the industry under a deep debt of obligation to them.

The Discussion on Carbonization.—Messrs. Duckham and Cloudsley, Limited, call attention to the fact that the figures given for Lausanne in the discussion on the "Carbonization" papers at last week's meeting of the Institution of Gas Engineers, referred to only a short period, and not to six months, as then stated. The figures over the whole time during which the plant has been in operation—namely, from Jan. 17 to June 9 of this year—are as follows: The make of gas has averaged 12,676 cubic feet per ton; 617 B.Th.U. gross; 13·2 per cent. fuel.

International Congress of Applied Chemistry.—The eighth International Congress of Applied Chemistry will be held in Washington and New York from the 4th to the 13th of September, 1912, under the patronage of his Excellency the President of the United States. The Hon. President is Professor Edward W. Morley, D.Sc., &c.; the President, Mr. W. H. Nichols, D.Sc., LL.D.; and the Secretary, Dr. Bernhard C. Hesse, 25, Broad Street, New York City. The work of the congress is divided into a number of Sections and Sub-Sections—among them being analytical, organic and inorganic, and physical chemistry, coal-tar colours and dyestuffs, fuels and asphalt, and law and legislation affecting the chemical industry. Papers will be accepted for reading and discussion in all the sections; preference being given to those specially adapted for international discussion.

SOCIAL EVENTS OF THE WEEK.

If anyone had been given a *carte blanche* order to choose the conditions for the Glasgow meeting last week, he could not have excelled those that were actually experienced. The atmospherical state was perfection. The sun shone; the temperature was comfortable for locomotion. The Corporation, headed by the Lord Provost (the Hon. A. M'Innes Shaw), and the Gas Committee, headed by Bailie Paxton, the Convener, together with the President and Mrs. Wilson, were profuse in their reception and entertainment of the visitors—both members of the Institution and their ladies. Great places of industry were freely thrown open, and were just as freely visited. Leisure time was devoted also to the sights of the city; and the Scottish Exhibition of Natural Art and Industry was a favourite place of resort. The beautiful weather was a temptation, when meetings and the prearranged social events did not call, to spend as much time as was physically endurable outside the several temporary habitations of the visitors. No small measure of praise is due to the Reception Committee, who acted in conjunction with the President in carrying through the details of the arrangements, and who co-opted representative members from the various quarters of the United Kingdom to assist them in looking after the general comfort. The local section of the Committee was composed of (put alphabetically), Mr. Walter Grafton, Mr. J. Harrison, Mr. S. B. Langlands, Mr. A. M'Leod, Mr. J. Middlemiss, Mr. Alex. Smith, and Mr. James Webster. The co-opted members were: Mr. George Airth, of Dundalk, Mr. J. W. Auchterlonie, of Cambridge, Mr. John Bond, of Southport, Mr. T. H. Duxbury, of South Shields, Mr. Lawrence Hislop, of Uddingston, and Mr. H. D. Madden, of Cardiff.

Luncheon by the Corporation.

If anyone has not visited the palatial City Chambers of Glasgow, then he has missed one of the great architectural beauties among municipal buildings. A description of the interior would make bald reading compared with the actual delight of inspection. It was in the large and handsomely decorated banqueting hall that the Corporation entertained the visitors to luncheon on Tuesday. It was an event in keeping with the reputation of the Municipality for hospitality. The tables were beautifully decorated, the luncheon excellent, the music choice, the speeches in line and appropriate to the occasion, and from the Lord Provost to the most remotely placed of his and the Corporation's guests the spirit of pleasure prevailed. Amid the grand surroundings, the members of the Institution and of the Corporation and Gas Committee numbered upwards of 500. There had been an intention to have the ladies seated with the gentlemen; but the acceptances flowed in to such a number that this was impossible. This fact, however, was not admitted to be one that was insuperable; and the Lord Provost, Bailie Paxton, and their colleagues were not minded that there should be any breach in their hospitality. Other rooms were available for the luncheon for the ladies; and in them upwards of 250 were entertained—Mrs. M'Innes Shaw, Mrs. Paxton, Mrs. Alex. Wilson, and many other local ladies, being present. While speech-making was proceeding in the large hall, delectable music was provided for the ladies. The toast of "Our Visitors: the Members of the Institution of Gas Engineers" was submitted by the Lord Provost; and it was responded to by the President. "The Corporation of Glasgow Gas Committee" was proposed by Mr. R. G. Shadbolt, the Vice-President (now President) of the Institution; and reply was made by Bailie Paxton. "The Chairman" was submitted by Mr. Edward Allen; and response was made by the Lord Provost. The speeches are reported on p. 849. An incident in the proceedings was the first introduction to the members of the kind memento—in the shape of a beautifully designed Chairman's hammer—of the visit of members of the German Association last October, which memento that body had forwarded to the President to transfer to the keeping of the Institution for use by occupants of the chair. After luncheon, the large company assembled in the quadrangle of the City Chambers; and there a photographic record was made of the occasion.

A Reception and Dance.

The hospitality of the Corporation did not end here. The City Chambers wore a very festive appearance the following evening, when the grand banqueting hall and other rooms were devoted to a reception and dance. Altogether hosts and guests numbered about 900; and they were received by the Lord Provost and his wife, Bailie Paxton, other city dignitaries, the President, and a number of ladies. The Lord Provost and the principal representatives of the City Council wore their robes and other emblems of office. Immediately after the reception, the ball room, the Council hall, and the long and spacious corridors were animated scenes. Bounteous provision, too, had been made for refreshment on the floor above. The ball room, with its excellently surfaced floor, was the favourite place. The younger folk had it very much their own way; but there were not a few ordinarily grave and dignified gas men who relaxed for the occasion and whirled and twirled with the youngest and best in the room. English, Welsh, and Irish engineers were seen engaging in the merry round with the Scotch ladies, and Scotch engineers found a big choice among the ladies who could not claim Scotland as the land of their nativity. Big as the room was, the dancers were plentiful throughout the evening, save in one item. That was the Scotch reel, and for this the visitors from across the Border had to leave the floor entirely to the Scotch laddies and lasses—the "laddies" were of various ages, and several in kilts; the lasses—they were, of course, all young and pretty. It was a good exhilarating sight; and the movements, though lively, were gracefully executed. Needless to say, the President's charming daughters were in the sets. Meanwhile, the concert in the Council Hall, by the Glasgow Orpheus Choir, was continuously well patronized, and deservedly so. But an end must come to all pleasures; and, soon after midnight, the last adieu for the occasion had been said in the entrance hall to the President and Mrs. Wilson, whose faces, late as the hour was, reflected their pleasure.

At the Scottish Exhibition.

On Thursday afternoon, a visit was paid to the Scottish Exhibition of National Art and Industry, on the invitation of the President and Mrs. Wilson. Large numbers were there well before tea was served in the Red Lion tea room in the Court of Music; and many were tempted to spend the whole evening at the exhibition. It was an occasion when fun could be indulged in. The side shows were well patronized—among them the Scenic Railway. Several gas men unbent for the occasion, and planted themselves on the "joy-wheel," with the lame excuse that their education in centrifugal force was somewhat incomplete. They were found, too, with their lady friends, examining into the mysteries of the baby incubators. But we must not say more. Sufficient it is to remark that plenty of genuine enjoyment was found that day at the exhibition—thanks to the President and his genial wife.

Excursion on the River and Firth of Clyde.

On Friday morning, the visitors were all astir early; for, business being over, the whole day was to be devoted to pleasure. Considering that many who had taken part in the previous proceedings and events of the week were leaving Glasgow on Friday, it must be granted that the company of 340 who boarded the special steamer—*Duchess of Hamilton*—at Broomielaw Bridge was a good one. It was soon noticed that Bailie Paxton, Bailie Kirkland, and other members of the Corporation Gas Committee, with their ladies, and the President, Mrs. Wilson, and the members of their family, were there; and it was a day of varied delights. The party was a big and friendly one. There was an absolute disinclination to talk "shop;" and a good thing too. It is a pity if one day out of four devoted to the annual meeting cannot be set aside solely for something else. Down the Clyde we went; and between the place of embarkation and Gourock, several large vessels were seen in the making—among them

a couple of noble-looking war ships. We left the great seats of industry, and steamed down the Firth and past the Cumbraes—penetrating farther and farther into the beauties of Nature for which this part of Scotland is world-famed. The bell rang hereabouts for luncheon; but luncheon had to be served in two parties. It was an excellent lunch; and it was wanted. Both after the first and the second parties had attended to the wants of the inner man and woman, there were a few toasts. The toast of "The King" was honoured; and all exercised their vocal powers with proper zest in rendering the National Anthem, seeing that we were within a week of the Coronation of the King and Queen. Then, after the first party's lunch,

The PRESIDENT proposed—"The Corporation of Glasgow and the Gas Committee;" coupling it with the name of Bailie Paxton. In the course of his remarks, he said that, when it was proposed to have the meeting in Glasgow, he had no doubts in his mind as to how the hospitable side would be dealt with, in view of the reputation in this respect of the City Corporation. He knew that the Council would live up to that reputation. Besides, he had, as the Convener of the Gas Committee, Bailie Paxton—a gentleman who, when he took a thing in hand, liked to do it in a thorough manner, or leave it alone. He had dealt with the present event very thoroughly. All through the arrangements, he had given instructions that the best possible was to be done for their visitors; and he (the President) would leave it with those present to say whether or not the Convener's instructions had been carried out. [The loud cheers were a sufficient attestation.] If there had been any omissions, blame must attach to those who had had to carry out the instructions, and not to Bailie Paxton. In conclusion, he expressed the hope that all had enjoyed their visit to Glasgow.

Bailie PAXTON, in responding, said he had thought that all talking had been done for the week; but he was glad to have the pleasure of saying a few words on the parting day. At the outset, he had to express the regret of the Lord Provost and Mrs. M'Innes Shaw at being unable to join the excursion that day, and to say how sorry they were at losing all participation in the pleasure. The Lord Provost and his good wife had given marked attention to the Institution of Gas Engineers during their conference. If those present knew, as he knew, how fully their time was occupied, they would, he was sure, be extremely grateful for the attentions of his Lordship and his good lady. He received the members, and gave them a cordial welcome, on the morning of the opening of the conference. He presided at the luncheon the same day; and the next day he and Mrs. M'Innes Shaw received the visitors at the reception and dance. If he (Bailie Paxton) was not mistaken, Mrs. M'Innes Shaw was also present at the reception by the President and Mrs. Wilson in the Red Lion Restaurant at the Exhibition on Thursday. So far as he (Bailie Paxton) was concerned, as Convener of the Corporation Gas Committee, he was twelve months ago sent to London with a mandate of the Lord Provost and Corporation to invite the Institution to hold their next annual meeting in Glasgow; and he was personally delighted to know how fully the members had responded to the invitation. The instructions he received from the Corporation had been carried out, and, he hoped, to the entire satisfaction of those present. He was personally proud to have met the members, and the Committee were delighted.

The PRESIDENT next proposed the "Reception Committee." He remarked that he believed the Committee had had a great deal to do with the success of the gathering. By some omission, a vote of thanks was not passed to them at the end of the meeting the previous day; but they intended to rectify that now. He had written to several gentlemen located in various parts of the country to ascertain whether they would assist in making the visitors to Glasgow as comfortable as possible; and he had met with a ready response to the invitation. They, along with various members of the staff of the Gas Department, had worked to make everybody happy. They had done this in such an unostentatious way that they had not been very much in evidence. But he personally knew how well they had performed their duty. He wished to thank them, and was sure the company present would also desire to do so, for the arrangements they had made. He coupled with the toast the name of Mr. Bond.

Mr. JOHN BOND remarked that he was honoured in having to respond to the toast; but he considered the honour should have been placed in the hands of the Convener of the Reception Committee. The task had been to all of them a very pleasant one, as they had been drawn into the genial society of the ladies; and the pleasures they had received would be ever marked on the tablets of their minds. The Reception Committee, however, felt that, without the aid of the Convener of the Gas Committee and the President, their efforts would have been practically in vain. On behalf of the Reception Committee, he thanked the President and one and all for the vote of thanks.

The second luncheon party had Mr. Edward Allen (one of the Vice-Presidents) to preside over it. He proposed "The King," and then "The Corporation and Gas Committee of the City of Glasgow." Bailie Kirkland, the Sub-Convener of the Gas Committee, responded. The "Reception Committee" was proposed by Mr. W. Langford, and replied to by Mr. Walter Grafton.

The while we were running round the end of Bute and on to Ormidale. Here for a brief space the party were allowed to land. The lovely scenery through the Kyles of Bute was subsequently enjoyed; and the happy journey was continued *viâ* Rothesay and Dunoon, thence up Loch Long. High tea was served during the latter part of the journey; and for the remaining time, to the music of the band on board, the novelty of an impromptu dance on deck was indulged in. Landing was made at Gourock, whence a special train conveyed the party back to Glasgow, which was reached about 6.30.

Thus ended the programme of a glorious visit; and next morning the greater part of the visitors left the Central Station by the ten o'clock London train, or by the Manchester and Liverpool train, starting ten minutes later. The President was on the platform bidding many farewells and speeding the parting guests. Thoughts and pleasant recollections will often return to the meeting of this year in Glasgow.

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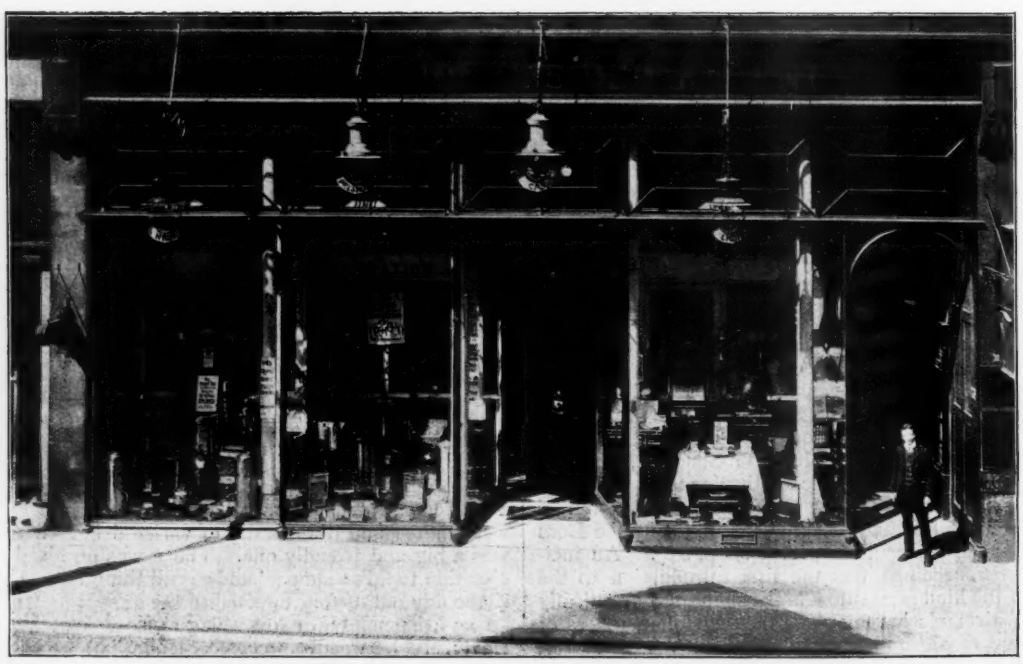

Some Views of the Interior will appear next week.

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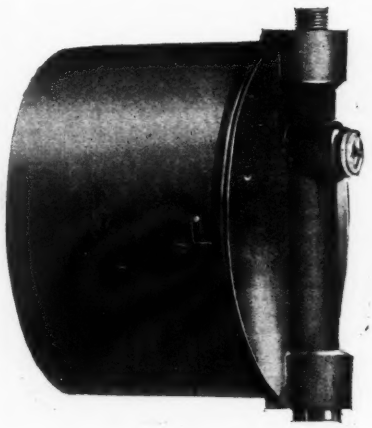

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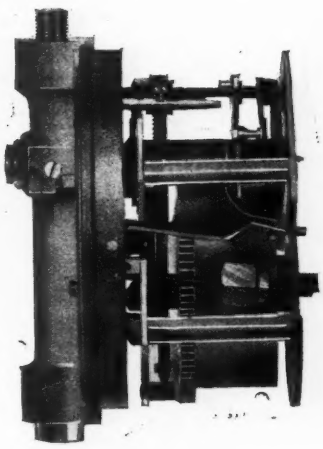

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GENERAL REPORT.

The Annual General Meeting of the Institution opened last Tuesday, in the Glasgow and West of Scotland Technical College, Montrose Street, Glasgow—Mr. ALEX. WILSON, M.Inst.C.E., the Gas Engineer and Manager to the Corporation, the President, in the chair. There was a large attendance.

The PRESIDENT opened the proceedings by briefly introducing the Hon. A. M'Innes Shaw (the Lord Provost) and Bailie Paxton, the Convener, and the members of the Gas Committee of the Corporation.

Welcome by the Corporation.

The LORD PROVOST thanked the President for his introduction. He said he desired, not only on behalf of his colleagues in the Corporation, but on that of the citizens of Glasgow generally, to extend to the members of the Institution of Gas Engineers a very cordial welcome to the city. He trusted the members would find many matters of interest there; and he hoped their sojourn would leave nothing but the pleasantest memories behind. He thought without undue egotism he might say that they had a great deal to show the members in the particular direction of inquiry in which they were engaged; and it would be no compliment to their President if he were not to claim that the gas undertaking of Glasgow was second to none in the United Kingdom. While the Institution had been fortunate in their selection of President, the Corporation of Glasgow had been fortunate in their selection of Gas Engineer, who followed in the footsteps of his well-known predecessor, Mr. William Foulis, who occupied the presidential chair of the Institute twenty-four years ago, on the occasion of their last visit to Glasgow. Mr. Foulis's work and career were well known to gas engineers all over the country; and the City of Glasgow owed much to his foresight and progressive policy in the development and progress of its gas undertaking. Instituted in 1863, and with a membership now of more than 800, composed of the scientific and technical advisers of the Municipalities of Great Britain, the Institution of Gas Engineers occupied a position of supreme importance in the industrial world, and was well entitled to the recognition of all great municipalities. He hoped later in the day to have a further opportunity of addressing the members; but, meantime, at the opening of their proceedings, he desired to repeat how pleased the Corporation were to welcome them. He felt sure that the proceedings of the conference would redound to the advantage of the great enterprise in which they were all collectively and individually interested.

The PRESIDENT returned thanks on behalf of the Council and members of the Institution for the kind welcome by the Lord Provost. They knew, he said, how fully his time was occupied, and therefore appreciated very highly his attendance that morning. The kindly welcome he had given would be a good send-off for their proceedings.

Confirmation of Minutes.

Mr. W. DOIG GIBB (London) moved that the minutes of the last annual meeting be taken as read and adopted.

Mr. F. W. GOODENOUGH (London) having seconded the motion, it was agreed to; and

The PRESIDENT signed the minutes.

Appointment of Scrutineers.

On the motion of the PRESIDENT, seconded by Mr. J. C. BELTON (Chester), Mr. J. Randall and Mr. W. S. Haddock (Warrington) were appointed Scrutineers.

Annual Report.

[See "JOURNAL" for May 30, p. 583.]

The PRESIDENT moved that the annual report of the Council and the accounts for the year ended Dec. 31, 1910, be taken as read and adopted.

Mr. SAMUEL GLOVER (St. Helens) seconded the motion.

Mr. GEORGE HELPS (Nuneaton) said it had never been his lot to read a better record of work done; and the remarks he wished to make were in no sense a reflection upon the work of the Council. In the first place, he regretted that the question of the reconstitution of the Institution had not made more progress; and he hoped before long to hear when it could be again taken up. If there were a minority on the Council, it would not be an unheard-of thing to add other members of the Institution to convert the minority into a majority. It behoved them all to think more of their industry than of themselves. No question could justly be raised against the awards. The men who read such excellent papers last year deserved all the recognition the Institution were prepared to give them. But he would ask why, in addition to the recognition accorded to the readers of the papers, some was not given to the men who did work which made the progress of the industry what they were all proud to talk about. What had they done for the first inventor of high-pressure lamps, the modern gas-fires, or the industry's latest achievement—vertical retorts? What he was saying was not a depreciation of Woodall, Duckham, and others, but an appreciation of Settle and Padfield, who, he thought he was right in saying, had something to do with the first vertical retorts. He regretted that the Gas Heating Committee was not to be reappointed. It might be said that the Committee had not done anything; but it was now getting into the position to do something. He hoped the new discovery of surface combustion had had nothing to do with the Committee giving up.

The PRESIDENT said the question of the reconstitution of the Institution was not lost sight of. It was only in abeyance for a little while. The other points raised by Mr. Helps would have every attention during the coming year.

The motion was then agreed to.

Presentation of Awards.

The following awards were then made by the PRESIDENT: The "London" Gold Medal (presented by Mr. H. E. Jones) to Dr. W. B. Davidson, for his paper on "Experiments in Carbonization on the Birmingham Coal-Test Plant." The Institution's Silver Medal to Mr. Jacques Abady, for his paper on "Public Lighting from a Municipal Point of View." The Bronze Medal to Mr. Sydney Y. Shoubridge, for his paper on "The Latest Installation of De Brouwer Stoking Machinery and Coke-Handling Plant."

The Late Mr. W. J. Jenkins.

The PRESIDENT said since the invitations were sent out for the meeting, the Society of British Gas Industries, and indeed the whole gas industry of the country, had sustained a severe loss through the death of Mr. W. J. Jenkins. Those who knew him best would miss him most; and they were all the poorer by the death of one who was so unassuming, so capable, and who had done so much for the betterment of their industry.

President's Address.

The PRESIDENT then delivered his Inaugural Address, which was given in the "JOURNAL" last week (p. 725). At its close,

Bailie PAXTON, as Chairman of the Glasgow Corporation Gas Committee, proposed that a hearty vote of thanks be accorded to the President for his able and interesting address. He said he was more than delighted that the Lord Provost had been able to attend and welcome the Institution to Glasgow. He wished to endorse all that his Lordship had said both with regard to his welcome and his appreciation of Mr. Wilson. While their organization was in a very good state indeed, some of them felt that they had a Court of Appeal which in many cases they could very well get rid of. By this he meant the Town Council. The Gas Committee, who were a part of the Council, considered that they could get on with the work much better if they had not to submit their proposals to this Court of Appeal; and he believed in his heart—and his brother Convener was of the same opinion—that the sooner they had a Local Parliament Bill the better.

Mr. R. G. SHADBOLT (Grantham), in seconding the motion, said one thing that stood out more than another in the President's address was his modest reference to his own work.

The motion having been carried unanimously,

The PRESIDENT returned thanks. He remarked that it had been his wish to say more on the subject of vertical retorts, but had abandoned his intention to do so on finding

that it was not usual to have a discussion on the presidential address.

REPORTS OF RESEARCH COMMITTEES.

The report of the Carbonization Committee was then presented, as follows:—

CARBONIZATION COMMITTEE.

REPORT ON PROGRESS OF CARBONIZING PRACTICE ON THE CONTINENT IN THE LAST TWO YEARS, PREPARED BY DR. R. LESSING, PH.D., F.C.S.

Laboratory, Southampton House, 317, High Holborn, London, W.C.

To the Carbonizing Committee,
The Institution of Gas Engineers.

Gentlemen,—In accordance with the instructions received from your Committee, I have prepared a summary of recent developments in the Continental methods and processes of carbonization which I have pleasure in submitting to you herewith. I do this with a certain amount of diffidence, and trust that you will appreciate the difficulties which anyone will have to encounter who attempts to depict with fairness, and some measure of clearness, the complexity of problems connected with modern-day carbonization of coal and the results so far achieved towards their solution and perfection.

Two years ago, when I had the honour of reporting to your Committee on the same subject, but without geographical limitations, I had occasion to allude to the rapidity and variety of the developments in this branch, and to the difficulty and delicacy of the task of accurately picturing the state of advance at any given moment. These difficulties have by no means diminished, but if anything are further enhanced and more accentuated, in spite of the fact that there is little to report which is new in principle or in application. In the period covered by my previous report, such outstanding features as the introduction of large-space carbonizing chambers could be recorded which, together with the great expansion of the Dessau vertical retort system, came as a surprise to many.

Though Continental gas engineers have not been startled by any striking novelties during the period under review, and individually took great pains to arrive at a general conclusion and decision as to the best carbonizing system, the long-desired settlement of this vexed question has not yet been effected, and controversy in fairly keen fighting spirit continues unabated.

The outlook, therefore, is not a very hopeful one as regards clearing up the differences involved, as, so far, controversy has been restricted to two systems—viz., intermittent verticals and chambers.

In this country, on the other hand, the period under review has been most fruitful in developments on other lines. The system of heavy charges has conquered, during the comparatively short space of two carbonizing seasons, a good deal of ground in English gas-works; and by means of modern quick-acting charging machines, the efficiency of the horizontal retort has been brought to a formerly unthought-of height. At the same time, great strides have been made in the further perfecting of continuous vertical retorts; and their successful adoption in a number of works leaves no doubt that this principle of carbonization in its various forms of construction has come to stay.

British gas engineers may congratulate themselves upon having once more overtaken by these two systems their Continental brethren in peaceful rivalry; for the system of heavy charges has not been extended on the other side of the Channel as rapidly as in this country, and the Continent can only boast of two installations of continuous vertical retort plant. As soon as they enter the front rank of competitive systems—as they have already begun to do—the difficulties of choosing will be enormously increased; and the war so far waged between two parties will be turned into a three or four cornered fight.

I shall refer later to some attempts made to put the results obtained in different plants on a common basis, but shall first give some technical and statistical details as regards the individual systems. Before doing so, I venture to draw the attention of your Committee to work done in connection with the testing of the raw material of carbonization.

The Testing of Gas Coals.

As is well known, Continental gas-works now carbonize, besides the coal mined in the various countries, a good deal of English, and also some Scotch, gas coals—more particularly gas-works situated on or near the coast. The highly efficient Continental waterways permit English coal to go also further inland and be delivered at reasonable prices far in the South.

At the well-known testing-station at Karlsruhe, it was considered advisable to systematically test the representative types of English gas coals used in German works, after having carried out very extensive investigations on the chemical composition and behaviour on large-scale carbonization of most of the German types of coal. Particular attention was given to ascertain whether or not the usual brands of coal actually represent a definite kind. This question was decided in the affirmative. So far, only the chemical analysis, together with the determination of calorific value, has been carried out; but the testing of ten-ton lots is proceeding. The results so far obtained and published refer to Durham, Yorkshire, and Scotch coals, and should be of great value to engineers in this country.

In this branch, as well as on the engineering side, it can be noticed that a good deal of useful spade-work is done in Germany—in this case, by the collection of facts and data without the pretensions of scientific research work; while original ideas as regards the approximate composition of coal have, in various instances, emerged from English laboratories. I may be allowed to refer in this respect to the extremely suggestive work recently done by Messrs. Burgess and Wheeler at the Altofts Coal-Dust Experimental Station.

Horizontal Retorts.

As has been indicated above, the question of heavy charges has not been so much accentuated on the Continent as in this country. In places where charging machinery is in use, the weight of charges has, of course, gradually risen; but completely filled retorts are very rare. The reason for this is that only very few works are fitted with through retorts; most of them having adopted inclined, vertical, or chamber settings in place of their old constructions when making a change.

The results experienced, where full charges were adopted, were much the same as in English works; a typical example of this being the gas-works at Stuttgart, where the Engineer, Herr Göhrum, achieved very good results with this system. In France and Italy, a tendency for heavy and full charges can be traced. As examples, may be cited a new bench of eighteen settings of nines at the Landy Station of the Société du Gaz de Paris, and ten settings of nines at the Turin Gas Company's works.

No charging machines of the efficiency of the leading British makes have been brought out on the Continent; but a number of devices for improved hand-charging and mechanical scoops for an even distribution of coal in the retort are being used.

Inclined Retorts.

There is nothing fresh to report on this type of plant, which, before the advance of verticals and chambers, had taken a firm hold especially on German gas-works. Continental engineers have found the expense of construction, and more particularly of working—as compared both with machine-charged horizontals and the modern plants—so heavy as to discourage their further extension.

Intermittent Vertical Retorts.

Bolz System.—A new system of intermittent vertical retorts was introduced soon after the publication of my previous report. It is the construction of Herr Bolz, of Budapest, who arranges twenty 4-metre retorts in one setting. The bench is situated sufficiently above the ground to allow of the generators and a number of water-gas producers being below. The hot coke discharged from the retorts can, by means of moveable shoots, be charged by gravity into generators, water-gas producers, or the coke-conveyor. The principal features claimed are economy in the handling of coke, the small number of generators required, large regenerating surface with a consequent saving in fuel, the regeneration on top of the generators requiring a minimum of chimney draught, small ground space and heat-radiating surface, the air cooling of charging floor and mouthpieces, accessibility, light and ventilation below the retorts and at the discharging mechanism, and the direct combination with the water-gas plant which requires no special house. After trying this system in an experimental setting at Triest, a plant for

750,000 cubic feet of gas per diem was put down at Agram (Austria), and has been working successfully since March last. It is going to be doubled.

Dessau System.—A further extension of this system can be reported, although the rate of expansion (which during 1907 and 1908 was extremely rapid) has not been maintained; However, the total number of retorts erected, or in course of construction, during the last two years outside the United Kingdom reaches the very considerable total of 2282. The large majority of the new installations are distributed over a number of countries; three plants of a combined carbonizing capacity of 3·8 million feet per diem being in France.

The principal technical advance made with the system consists in the placing of three rows of six retorts each in a setting. The capacity of each retort is reduced by 15 per cent., as against the retorts in the two-row settings, with a consequent increase in heating surface. The three retorts in a cross row are manipulated together, charged from a common hopper with 1·5 tons of coal; and the coke is also discharged simultaneously from the three retorts on to the conveyor. A great saving of labour, fuel, and space are the advantages claimed for the improved model, which has been adopted in nearly all Dessau plants ordered or erected during the past year.

The question of the admission of steam to Dessau vertical retorts has been further discussed; and the practice of water-gas making in the retort is being encouraged by the advocates of the system.

This procedure seems to have beneficial results in compensating differences in temperature which occur in "dry" working, and appears to be necessary for a uniform carbonization in all zones of the retort—a result not so easily obtained without the admission of steam.

Continuous Vertical Retorts.

As has been pointed out in the introductory remarks, the application of the continuous principle to vertical retorts has so far been somewhat neglected on the Continent. Engineers appear, however, to regard this product of purely British thought with less and less suspicion, and begin to realize that the system has successfully emerged from its experimental stages.

Woodall-Duckham System.—The only plant installed on the Continent of Europe since reporting last, is a Woodall-Duckham one at Lausanne, Switzerland. It consists of twelve settings of four retorts each. The retorts are 25 feet long, and elliptical in section. Each setting has its own producer and regenerator, and is of a capacity of 10 tons per 24 hours, or 120 tons (= 1,500,000 cubic feet) per 24 hours for the entire plant. Six settings of the plant have been making the whole of the gas needed for the town of Lausanne since the beginning of January last, and are stated to be giving satisfaction as regards make and quality of gas, coke, and bye-products, as well as fuel consumption. There is no specimen of the Woodall-Duckham improved "slot" retort working on the Continent; but in a plant ordered by the Corporation of Dresden, this model has been adopted. A plant of two settings on the slot system is in course of erection at Ipswich (Queensland).

Glover-West System.—This system of continuously working verticals is not yet represented on the Continent of Europe; but there are plants of this type in course of erection at Tokio for 2 million cubic feet of gas per day, at Sydney for 4 millions, at Newcastle (New South Wales) for 1 million, and an installation at Fitchburg, Mass. (U.S.A.). Seeing that so much has been done to remove the mechanical difficulties connected with continuous carbonization—notably in the system for which Mr. Alexander Wilson, the President of the Institution, is responsible—a more general appreciation and extensive application of this principle by Continental gas engineers may be expected.

Chamber Settings.

The large-space carbonizing chamber has maintained the position to which it was raised so rapidly about three years ago, and has gained ground. The number of chambers erected and under construction since June, 1909, has reached nearly 1000, with a daily productive capacity of more than 70 million cubic feet of gas.

Munich (Ries) Ovens.—The later types of these inclined chambers embody some new features; and a different method of heating has been adopted. While formerly the heating gases passed over the top of the coking chambers, the crown of the chamber remains now at a much lower temperature—an alteration conducive to an increase in illuminating power and to freedom from naphthalene. Charging from hoppers through the top of the chambers has been adopted in the place of that through vertical charging doors in the back wall of the setting. Considerable reductions in the labour account are claimed for the more recent plants.

Koppers Settings.—This firm has now entirely adopted the horizontal type of chambers. The Koppers plant at Innsbruck supplies the town exclusively with chamber gas. Very considerable extensions of the Vienna Gas-Works, where a battery of inclined chambers was erected in 1908, consist of horizontal ovens, with mechanical coke-pushers. The special feature of the Koppers system is the arrangement of independent vertical heating flues, which extend into a common horizontal flue along the crown of the chamber. Superheating of the distillation gases is thereby avoided. The special regenerators of this system also deserve mention.

Klönne Settings.—The battery of inclined chambers at Königsberg has been augmented to the proposed number of 24 ovens; but Messrs. Klönne have recently principally devoted their attention to horizontal chambers, of which a number have been erected at Rixdorf, Padua, Frankenthal, Versailles, St. Gilles, Tilburg, Haag, and Brescia.

Coke-Oven Gas for Town Supply.

One aspect of coal carbonization in ovens is worthy of especial mention—viz., the supply of coal gas from industrial coke-ovens to townships. This problem, which has assumed practical shape only in one or two tentative cases in this country, has become of very considerable importance in the Rhenish-Westphalian industrial districts of Germany. Among the towns already supplied with coke-oven gas bought from the mine-owners are Essen, Mühlheim, Gelsenkirchen, Bochum, and Barmen; and a Company has been formed for the purpose of supplying a combination of towns, among them such important places as Elberfeld, Barmen, Düsseldorf, and Krefeld, with gas direct from the collieries. In this connection, I may mention that a battery of Elliott-Jones vertical coke-ovens—a system of English origin—is in course of erection near Oberhausen, Germany.

Mechanical Producer.

I venture to draw attention to a type of producer which, although known in steel works practice, may claim novelty as an adjunct to gas manufacture. This is the Kerpely producer, invented by Herr Kerpely, an Austrian steel-works manager, the main feature of which is its rotating base, upon which a conical grate is fixed in an eccentric position. By the movement of the base at the rate of about one revolution per hour, the ash is prevented from clinkering, and is discharged automatically. Air and steam being evenly distributed over the whole cross-section, the gasification efficiency is of a high order. A set of four of these producers is in use for the heating of some of the Vienna chamber settings, and sixteen others are in course of construction. A producer on similar lines was designed by Rehman, but has not yet been introduced into gas-works practice.

Comparison of Various Carbonizing Systems.

As has been mentioned before, it is well-nigh impossible at the present moment to accurately gauge the balance of opinion as to the various merits and demerits of the different carbonizing systems. Some very useful work has been done in the direction of thoroughly testing plants on a full or partial working scale, and a good many results have been obtained and published. Although in most cases the standing of the independent experts employed does not allow of the slightest doubt as to the reliability of the figures obtained and the statement made by them, it is only natural that the parties to whose order or commission these trials were carried out should exercise a certain amount of selective discretion in the publication of these; results nor are the conditions of testing always comparable. The task of drawing up a true balance-sheet for competitive systems is thereby made all the more difficult. When studying the discussions at the various meetings at Innsbruck, Schwäbisch-Gmünd, Berlin, and Flensburg, which have been fully reported in the Technical Press, and in the course of which authoritative statements were made by representatives and in favour of vertical retorts and inclined and horizontal chambers, an impression is forced upon the impartial student that, taking all points into consideration, there is not much to choose between them, and that the final

decision in each case would depend upon local conditions and requirements.

Within limits, this is also the final verdict of a very interesting study of the problem published quite recently by Messrs. Terhaerst and Trautwein. These gentlemen compare the four types: Dessau verticals (eighteen's), chambers, horizontals with charging machines, and inclines. They discuss the yields of gas, coke, and ammonia, the calorific multiples of pure coal gas, compare the gas made in verticals with admission of steam with mixed gas from the other systems in conjunction with separate water-gas producers, and calculate finally the cost of working, including establishment charges. They come to the conclusion that, within certain limits, the carbonizing efficiency is the same in all systems, apart from differences in bye-products and naphthalene. They calculate the cost of working, including capital charges, to be lowest with horizontal retorts and highest with inclined retorts; verticals and chambers occupying an intermediate position.

A Suggestion.

Before concluding this report, I venture to submit a suggestion to the consideration of the Committee which, if adopted, would be useful in the comparative examination of carbonizing systems. As indicated before, the published results of carbonizing trials are in many instances lacking that uniformity of conditions which is indispensable for a comparison of real value. Although I am well aware that it would be impossible to have these tests carried out under the same conditions on plants varying widely in size, arrangement, and testing facilities, I venture to think that matters could be greatly simplified by standardizing at least the expression of working results. A good deal of apparent inconsistency could be avoided if the statements of yield, quality, and costs were to be reduced to a common basis, making it clear at the same time whether the gas made was coal gas only, or if, and to what extent, water gas was made in the retort. I have no doubt that the discussion upon the large number of papers to be read on the subject of carbonization at the forthcoming meeting of the Institution will sufficiently emphasize the desirability of uniformity in this direction.

(Signed) R. Lessing.

APPENDIX I.

Dessau Vertical Retorts

Erected and Under Construction since June, 1909 (outside United Kingdom).

—	Number of Settings.	Number of Retorts.	Capacity of Plant in Cubic Feet per 24 Hours.
Germany.			
Chemnitz	6	60	850,000
Duisburg	5	50	700,000
Frankfurt o/O	5	50	700,000
Hanover	5	90	1,300,000
Lichtenberg	3	54	700,000
Meissen	2	20	285,000
Oberschles. Gaszentrale	5	50	700,000
Reutlingen	4	38	540,000
Hildesheim	4	60	700,000
Burg bei Magdeburg	3	30	340,000
Insterburg	2	20	285,000
Pforzheim	5	90	1,235,000
Metz	6	96	1,130,000
	55	708	9,465,000
France.			
Marseilles	12	120	1,700,000
Nancy	5	50	700,000
Tourcoing	10	100	1,410,000
	27	270	3,810,000
Holland.			
Amsterdam	30	540	7,420,000
Arnheim	3	54	742,000
	33	594	8,162,000
Russia.			
Warsaw	10	180	2,120,000
	10	180	2,120,000
America.			
Providence	6	60	850,000
Rio de Janeiro	14	140	1,975,000
	20	200	2,825,000
Australia			
Melbourne	15	270	3,700,000
Wellington	6	60	850,000
	21	330	4,550,000
Total	166	2282	30,932,000

APPENDIX II.

Chamber Settings.

Erected and Under Construction since June, 1909.

—	System.	Type.	Number of Settings.	Number of Chambers.	Capacity of Plant in Cubic Feet per 24 Hours.
Germany.					
Munich-Moosach	Ries	Inclined	15	45	3,570,000
Hamburg-Grasbrook	,,	,,	14	42	3,460,000
Berlin-Tegel	,,	,,	27	81	5,650,000
Leipzig	,,	,,	16	48	3,500,000
Hanau	,,	,,	8	24	1,240,000
Ratisbon	,,	,,	7	21	890,000
Halberstadt	Koppers	,,	..	9	450,000
Königsberg	Klönne	,,	4	16	1,170,000
Rixdorf	,,	Horizontal	..	20	885,000
Frankenthal	,,	,,	..	10	355,000
Deutscher Kaiser Iron Works	Koppers	,,	..	124	15,000,000
				440	36,990,000
Austria.					
Vienna	Koppers	Inclined	..	15	1,300,000
Vienna	,,	Horizontal	..	118	15,000,000
Innsbruck	,,	,,	..	18	780,000
				151	17,080,000
France.					
Paris-Genevilliers	Ries	Inclined	20	60	2,170,000
Paris-La Villete	,,	,,	32	96	5,650,000
Versailles	Klönne	Horizontal	..	8	350,000
St. Gilles	,,	,,	..	18	700,000
Elbeuf	Koppers	,,	..	6	250,000
				188	9,120,000
Italy.					
Rome	Ries	Inclined	32	96	6,100,000
Padua	Klönne	Horizontal	..	16	700,000
Brescia	,,	,,	..	12	425,000
				124	7,225,000
Holland.					
Tilburg	Klönne	Horizontal	..	16	565,000
Haag	,,	,,	..	32	1,410,000
				48	1,975,000
			Total	951	72,390,000

On the motion of Mr. S. Y. Shoubridge (Lower Sydenham), seconded by Mr. J. Ferguson Bell (Derby), the report was taken as read, and adopted.

Gas-Heating Research Committee.

Mr. E. W. Smith, M.Sc., presented the Third Report of the Gas-Heating Research Committee, as follows:—

GAS HEATING RESEARCH.

THIRD REPORT OF THE COMMITTEE APPOINTED BY THE INSTITUTION OF GAS ENGINEERS IN CONJUNCTION WITH THE UNIVERSITY OF LEEDS.

Prefatory Note.

The following report contains an account of the continuation of the investigations carried out by Mr. E. W. Smith, M.Sc., under the direction of the Committee. The results described are of some experiments with water gas and Mond gas, which it should be understood were not undertaken with the expectation that existing gas-stoves would be serviceable with such gases, but rather with a view to studying the effect on radiation efficiency of calorific impoverishment and of marked changes of composition in the gas used.

The remainder of the report embodies the account of a series of experiments relating to the construction of the burner. These experiments are neither detailed nor exhaustive, but the Committee venture to hope that they may be useful in indicating the lines which such experiments should take.

The work of the Committee was terminated owing to the appointment of Mr. E. W. Smith to an important position in connection with the Birmingham City Gas Undertaking. After full consideration of the circumstances the Committee decided not to ask for reappointment. They felt that it would be extremely difficult to replace Mr. Smith, and that in any case the work must suffer a long interruption. In addition to this the establishment of a University Advisory Committee, consisting largely of representatives of the Institution of Gas Engineers, in connection with the Livesey Professorship at Leeds, seemed

to make it convenient that this Research Committee should relinquish its independent existence.

In concluding their work the Committee would again record their warmest appreciation of the great zeal and ability with which Mr. E. W. Smith has carried out the experimental work.

(Signed) ARTHUR SMITHELLS (*Chairman*).
JOHN BOND. J. H. BREARLEY.
WM. A. BONE. J. B. COHEN.
CHARLES WOOD.

The increasing use of gases of lower calorific value for industrial purposes led the Committee to believe that a useful purpose might be served by a study of the effect of the use of water gas or Mond gas in the present type of gas fire. Facilities were kindly granted by two Leeds firms to make these tests; one having a water-gas plant and the other a Mond gas plant. The radiometer, calorimeter, and all the other apparatus necessary to the work were transferred from the Fuel Department of the University to these works, where every accommodation was provided, and gas and water laid on. Samples of gas were taken regularly and analyzed at the University. Arrangements were made for all the determinations to be carried out as described in the first two reports of the Committee.

WATER GAS.

The first series of experiments were made with water gas.

It was very soon found that all the primary air had to be dispensed with, and the inlets round the nipple completely made-up. The slightest leak at this point caused the flame to light-back.

A 10-inch stove having columnar "fuel" was used with a flue, 3 inches in diameter and 6 feet high, opening into the atmosphere. This stove under coal gas had a radiant efficiency of 38 per cent.

The calorific value of the gas remained fairly constant. A Boys calorimeter was used, and the calorific value as calculated from an analysis of the gas very closely approximated that obtained by experiment.

The consumption of gas was regulated so that the flame completely filled the "fuels."

The following results are the mean of three full experiments; no experiment varying more than 2 per cent.

	Determined.	Calculated.
Calorific value of the gas at 0°C and 760 mm. dry	78·83 gross .. 71·73 net	78·64 gross .. 71·54 net
Gas rate in cubic feet per hour at 0°C and 760 mm. dry		38·6
Total calories evolved		2768
Total calories radiated		1104·5
Percentage of heat radiated		41·57
Barometric pressure		29·64" Mercury

A typical analysis of the gas is—

CO_2	7·15	O_2	·5
CO	37·05	CH_4	1·85
H_2	48·45	N_2	5·00 (by difference)

The appearance of the fire could not compare in its incandescence with a coal-gas heated fire.

The figures for the percentage heat radiated indicate that a water-gas heated fire has as high a radiant efficiency as under coal gas—if not higher.

The efficiency is calculated on the total number of calories available—this figure being the product of the gas-rate per hour and the calorific value per cubic foot of gas.

This size of stove would require 19 to 20 cubic feet of gas per hour when working at its highest efficiency.

From the figures it will be seen that this quality of gas might be used in gas stoves, but on the grounds of cost and appearance the use is hardly practicable.

MOND GAS.

While it had been found comparatively simple to adopt water gas to heating gas-fires mainly owing to the fact that a water-gas flame is as wide as, if not slightly wider than, the usual coal-gas flame obtained in gas-fires, it was not found possible during the whole of the experiments on Mond gas to obtain a higher radiation efficiency than 30 per cent.

In the first place great difficulty was experienced in getting a sufficiently large consumption of gas in the stove.

All primary air inlets were closed. The pressure of the gas was raised from 8-10ths of water to 24-10ths.

The nipples were increased in bore until it was found necessary to take them out altogether; the gas entering the burner direct from a ½-inch pipe.

When a consumption of 80 cubic feet per hour was reached, the flame appeared at the top of the "fuels." The same stove with coal gas required about 20 cubic feet per hour.

On examining the passage of the flame up the columns of "fuel," it was seen that even with a consumption of 80 cubic feet per hour with the flames appearing above the "fuels," the flames were so attenuated that there was practically no contact between them and the inside of the "fuels."

An attempt was made to remedy this by opening out the burner holes from 5-16 inch to 7-16 inch. This improved the radiation efficiency very slightly.

Since the attenuated shape of the Mond gas flame made it impossible to conveniently fit it to the "fuel," another type of "fuel," having a narrower passage up the centre, was tried. It was found that although it was no longer possible for the flame to pass directly through it without coming into contact with the "fuel," no better radiation efficiencies were obtained. It was very noticeable that whereas with coal gas and water gas the burning gases appear to cling to the "fuels," with Mond gas no such thing occurred.

	Determined.	Calculated.
The calorific value of the Mond gas was	38·57 gross .. 34·17 net	39·24 gross .. 35·0 net
Gas analysis—CO_2		17·6 per cent.
CO		10·2 ,,
CH_4		3·9 ,,
H_2		24·5 ,,
Total combustibles		38 6 ,,

It will be seen that of the 38·6 per cent. of combustibles, 24·5 per cent. was hydrogen.

It may be shown by calculation that the relative amounts of radiation observed in the above tests nearly correspond to the relative calorific intensities of the gases employed, having regard to the heat capacities of the products of combustion in each case.

EXAMINATION OF SOME BURNERS AND NIPPLES USED IN THE PRESENT TYPE OF GAS-FIRES.

The last subject undertaken for examination by the Committee was that of the burners and nipples at present in use in the various types of gas-fires now in use. It is a difficult subject to attack, as there are so many variable factors to be taken into consideration.

In the first place it is necessary to decide what shall be the essential features of a perfect burner and a perfect nipple.

Taking the burner first, it will be generally conceded that this should be so constructed as to give flames which, when sufficiently aerated, will give an intense heat, produced by intimate contact, over the whole of the fuel. To attain this, the pressure of the gas at the nipple and the amount of the primary air admitted are of as much importance as the general construction of the burner or the bore of the flame jets themselves. It was decided, for comparative purposes, to make the test on all burners and nipples at a constant pressure.

Another thing to be aimed at in the construction of the burner—and this is a point that depends solely on its construction—is the attainment of flames absolutely equal in length and aeration. This is a difficult matter, as will be realized by anyone making but a casual examination of burners now in use. The flow of gas through the tube or tubes of the burner will always be in the direction of least resistance, and as there is rarely a separate supply arranged for each jet, it is almost inevitable that there will be a difference in the pressure of the mixture of gas and air at each of the flame jets.

Some firms have endeavoured to overcome this by boring the flame jet holes of different diameters, in order to check a difference in length of the flames—the wide holes usually being those in the centre of the burner. This only partly gets over the difficulty, as not only is the flame lengthened but it is considerably widened.

It appears as if the only practical way of obtaining a series of flames identical in shape on one and the same burner is to so construct the burner that the same pressure is obtained at each of the flame jets. While a series of two or three or more tubes either in series or partially in parallel are the rule in burner construction such things as sharp angular bends or dead-ends, except where their effect is neutralized by other means, should be avoided.

In the last case it is inevitable that the initial pressure will be considerably reduced, and it is better therefore that sharp angular bends should be entirely eliminated. There seems to be no doubt from the observations made during the progress of this work, both upon burners now in use and upon adaptations made in the laboratory, that the simpler the system of tubes in burner construction the better it is. Of the burners examined, those which most nearly approached in construction a flat rectangular box with flame jets attached to the top narrow edge, gave the greatest evenness of flames.

The question of correct aeration, and how to attain it in the simplest way under the widely divergent conditions of varying pressures and varying gas composition found in different towns, and only too frequently found in the same town, is one which demands much attention.

Owing to the wide range of pressures to which the gas-stove is subjected it is absolutely essential that the nipple and burner together should be capable of as wide a range of aeration as possible.

It should be possible to have a burner and nipple so adjustable that it will give a flame with a given consumption which is so well aerated that it will light-back at either 5-10ths or 30-10ths pressures, and at the same time by cutting down the aeration give a luminous flame. Only the burner and nipple which are capable of such a range have a right to claim the capability of being used between these pressures.

There are three things which control this range. They are:

1. The formation of the mouth of the burner.
2. The arrangements in the nipple for controlling the amount of air that shall be pulled into the burner.
3. The construction and capacity for control of the velocity of the gas and the gas consumption through the jets in the nipple.

It is difficult to publish the results of work done on this subject in detail, as it would entail the bringing into special prominence for inferred praise or censure some of the various appliances now to be purchased. But without doing this, it is possible to state in a general way what conditions were found to give the best results.

Taking the last of these three conditions first: It is found that it is better to have the nipple bored with three, four, and five holes than with only one or two holes, and that it is better to control the passage of gas through the nipple by cutting out (when reducing the consumption) one or more holes rather than by turning off the control tap, or in some other way cutting down the pressure at the jet or jets. The explanation of this is simple, but, though obvious, it is perhaps worth stating.

To provide a given delivery the gas will pass through a single jet at the same velocity as it would when divided into two or more jets to provide the same delivery; but in the last case the sum of the superficial areas of all the streams of gas is much larger than the area of the single stream of gas delivering the same volume. The extent of contact with the air of the four or five streams is consequently greater than that of the single stream; and more air is therefore injected into the burner.

To reduce the consumption in a given stove for installation adjustment, if the pressure is reduced by turning off the control cock, or by blocking up the single jet by means of a screw or some other arrangement, the pressure at the jet is reduced, with a consequent drop in the velocity of the gas issuing from it, and a change in the relative amount of air injected into the burner is brought about. But if the consumption is reduced by cutting out one or more jets, the velocity of the gas issuing from the remaining jets is not only undiminished but is slightly increased—the volume of injected air remaining relatively much the same, and being proportional to the number of jets.

Air can then be drawn in from the very base of the outflowing column of gas, and a clean and distinct flame (if the gas is lighted at the jet) is the result. Otherwise, there is eddying and feathering and inefficient results.

It would be well in low pressure nipples if means were provided in the surface of the nipple—in the form of air inlets—which would allow of the air being drawn in between the gas jets.

Methods and Results.

In order to study the effect on the aeration of the flames of a low-pressure gas-fire burner one must know the composition of the mixture of gas and air which is found in the burner directly before the flame jets.

For this purpose all the burners tested were drilled with a $\frac{3}{8}$-inch hole immediately below the centre flame jets. Into this was ground and soldered a copper tube, through which a slow stream of the gas and air mixture could be drawn for analysis. A sample of the gas was also taken from the gas supply immediately behind the nipple.

The samples of the gas as well as the samples of the mixture were analyzed for carbonic acid and oxygen. The percentage of oxygen pulled into the burner was calculated from these analyses.

Taking the atmosphere as consisting of four parts of nitrogen to one part of oxygen—this figure being sufficiently accurate for the purpose—the volume of air injected was obtained.

For comparative purposes, the percentage of gas was divided by the volume of air injected. For instance—

Volume of oxygen found in gas	=	0·5 per cent.
,, ,, ,, mixture	=	14·0 ,,
Therefore volume of air in the mixture		
5 (14·0 − ·5)	=	67·5 ,,
,, percentage of gas in the mixture. .	=	32·5 ,,
and comparative figure = $\frac{32·5}{67·5}$ . .	=	·4815

The larger the volume of air injected, the smaller will this figure be. If it were possible to inject at low pressures sufficient air for complete combustion, this figure would be reduced to about ·1600.

No useful purpose is served by comparing the capacities for air injection of different types of nipples and burners.

If a 12-inch burner having seven flame jets requires an aeration which corresponds to the figure ·324 with a given consumption, it would require a much smaller aeration if the number of flame-jets were increased, the consumption of gas remaining the same.

It will be seen from figures given later that for this reason each type of burner requires a different range of air injection to produce the correct flame for that type.

What has been done has been to take each maker's burner and nipple and to determine the range they were capable of giving, and making notes of the types of flames produced at different points in this range. The burners tested will be referred to from now as A, B, and C.

The correct gas consumptions were:	"A"	25 cubic feet per hour.
	"B"	18 ,, ,,
	"C"	20 ,, ,,

Taking burner A first, with a pressure before the jet of 2 inches of water, it was found that—

The maximum aeration gave	·3700
Aeration for semi-luminous flame	·4552

From this it will be seen that there was very little range with the burner as sent out; the greatest aeration only producing a barely stiff flame.

The face of the nipple when in position was flush with the mouth of the burner, which consisted of a plain tube, of $1\frac{1}{4}$"-inch diameter, with parallel sides. The effect was tried of inserting the nipple $\frac{1}{2}$ inch inside the mouth of the burner and $\frac{1}{2}$ inch away from the mouth of the burner. Very little difference was made in the volume of air pulled in owing to the shape of the mouth.

Half inch inside the tube	·3820
,, from the tube	·3725

Both flames were barely stiff.

It was not surprising that so little difference in the air injection occurred, as the mouth of the burner would only allow a column of air $1\frac{1}{4}$ inch wide to enter it, and any wide column set in motion would be pared down to $1\frac{1}{4}$ inch when it reached the tube. In none of the burners examined were the usual conditions of a cone-shaped hole found—as in the steam injector.

The effect was then tried of cutting-down the gas consumption by putting out of action one of the jets in the nipple. In this way the remaining jets had a slightly increased pressure, whereas, if the cock had been turned off, all the jets would have had a much reduced pressure of gas behind them.

20·7 cubic feet per hour gave a slightly noisy flame . .	·3106
18·5 ,, ,, ,, noisier flame	·2969

It has already been pointed out that a reduced flame brought about by a decreased consumption will produce an increase in the stiffness of the flame owing to the increased surface-contact with the atmosphere of the flame

compared with the volume of the flame. This will account for the greater stiffness of the flame in this case.

The Constricted Tube.

Opinion is still divided as to the advantage or otherwise of a constriction in the first tube of the burner.

It is sometimes claimed that it increases the amount of air drawn into the burner, but most often and more justifiably, perhaps, it is claimed that its effect is to better mix the gas and air in their passage through the burner.

The large number of bends and turnings the gas has to take in its passage from the nipple to the flame jets should bring about a sufficiently efficient mixing of the air and gas for any flame it may have to give. A disadvantage of the constriction is that it actually cuts-down the volume of air pulled into the burner owing to the back-pressure it induces—the velocity of the gas changing between the inlet to the constriction and the outlet.

In all cases, the advantage indicated was due entirely to the increased diameter of the burner mouth and the burner tubes as a whole. In order to determine the exact effect of a constriction, the burner A, having primarily parallel sides, had inserted into it a well-made, finely-tapered, polished wooden constriction. No better flame was produced. In fact, the amount of air drawn through the burner was reduced, the figures obtained being—

Without constriction, consumption 25 cubic feet per hour .	·3750
With ,, ,, ,, ,, .	·4500

Burner B.

This burner was so constructed as to give a few long flames. There was consequently a need for greater aeration than in burners constructed to give a large number of smaller flames.

The effect of this can be seen in the following figures :—

1. 18 c. ft. per hour.	Correct flame	·2912
2. ,, ,,	Maximum air	·2626
3. ,, ,,	Minimum air adjustable, luminous.	·4710
4. ,, ,,	Constriction and as (2)	·2732

The burner had a much greater range of adjustment than A. It could be made to fire-back, and would give a luminous flame at will.

Burner C.

This burner gave the best results of all. Whereas in other burners either there was a difference in length in some flames or a tendency to splurt sideways in the end flames, in C the flames were steady and of even length.

The burner had a good range, this being due mainly to the better aeration arrangements, and to the fact that in order to obtain even-sized flames, baffling effects found in many other burners had been dispensed with, and the construction was such that there was a minimum of interruption to the passage of the gas on its way from the nipple to the flame jets.

Owing to the burner being constructed so as to give a slightly smaller flame than B, but larger than A, the amount of aeration necessary was less than B, but greater than A.

19·8 c. ft. per hour.	Correct flame	·3083
,, ,,	Maximum air, flame noisy . . .	·2430
,, ,,	Minimum air, luminous flame . .	·4300

Most burners examined were quiet when correctly adjusted; but it was noticed that the wider and longer the intake tube of the burner was, and the more the intake air was baffled before being taken in, the greater was the noise, especially if the tube was wide, say $1\frac{3}{4}$ inches, and had parallel sides.

This investigation on burners was not complete, when the work was discontinued.

The Committee in its work has not attempted to design a new gas-fire, or even some of the parts of the gas-fire. This was not its function. It has attempted to make an exhaustive examination of the working principles of the present type of gas-fire, and, in some measure, to indicate the lines on which improvements might be made.

Mr. John Bond (Southport), in moving the adoption of the report, said he wished to tender the thanks of the Committee to Professor Smithells and to Mr. Smith, the Research Chemist, for the work they had carried out. Personally, he was sorry the work had been suspended; but he was looking forward to the day when the Livesey Memorial Committee would take in hand gas-heating research work.

Mr. W. R. Herring (London), in seconding the motion, associated himself with what Mr. Bond had said.

Mr. George Helps said he thought that, among the members of the Committee, there had been too much science and too little practice. He did not see the name of a single practical burner-maker on the Committee. Had anything been done with regard to the carburetting of modern gas on a consumer's premises, to be used in gas-fires? A lot of time had, in his opinion, been wasted in testing gas at low pressure. In the report, it was stated that the gas would pass through a single jet at the same velocity as it would do when divided into two or more jets to provide the same delivery; but in the latter case the sum of the superficial areas of all the streams of gas was much larger than the area of the single stream of gas delivering the same volume. He totally disagreed with this statement. He had a list of 59 tests of supplies which all went to prove that in the case of a nipple with a thin plate at the top, friction could be neglected. If the report had stated that the sum of the superficial peripheries, and not the superficial areas, was to be much greater than the area of a single nipple to pass the same quantity of gas, he could have understood it.

The President remarked that the point raised by Mr. Helps, of having a practical burner-maker on the Committee, was worthy of consideration.

The report was then adopted.

Professor Smithells said as this was practically the Committee's last appearance, he, as Chairman, would like to take the opportunity of saying how very much indebted they had been to Mr. Smith for his devoted service to the Committee. He shared the confident hope that had been expressed that the Committee would not be suspended for very long; and he trusted that the union which it had largely brought about between the forces of the industry and the forces of the University with which he was connected would secure that work of the kind the Committee had done would be extended, and that it would contribute largely to the benefit of the gas industry. The most gratifying thing, so far, with regard to the work that had been done had been the acknowledgment of those who were concerned in the manufacture of gas-burners that it had been of considerable value to them. This, after all, was the test of the utility of their work. He hoped the effects of the work to which the Committee had set its hand would long continue. The relations of his University with the Institution of Gas Engineers had been of great advantage to the former. As the Chairman of the Committee, he had to acknowledge many acts of courtesy by the Institution, and particularly by Mr. Dunn, the Secretary.

The President thought he was quite safe in predicting that the work of the Committee was only suspended. Although they had lost Mr. Smith, he had no doubt that Professor Smithells would bring forward another young man who would prove as devoted to the work.

REFRACTORY MATERIALS COMMITTEE REPORT.

STANDARD SPECIFICATION FOR RETORT AND FIRE-BRICK MATERIAL.

Section II.—Fire-Bricks, Blocks, Tiles, &c.

The Refractory Materials Committee submit herewith the second section of the standard specification, details of which, as with the first section, have been drawn up by a Joint Committee under the Chairmanship of Dr. H. G. Colman, and formed of representatives of the Retort and Fire-Brick Section of the Society of British Gas Industries, and of the Refractory Materials Committee. Dr. J. W. Mellor, the Principal of the Staffordshire County Pottery Laboratory, has again acted as Technical Adviser to the Sub-Committee.

The same course has been followed as previously, and samples of representative bricks from the principal districts where fire-bricks are produced have been tested, and due regard paid to the results of these tests when deciding upon the terms of the specification.

No tests have been specified for porosity; but it is proposed to give further consideration to this point, especially with regard to the chequer-bricks for carburettors and superheaters of carburetted water-gas plants.

The Committee would again draw attention to the fact that the specification is not a final one, but that its clauses as now drawn up are intended to give a lead to develop-

ment in their several directions, and will be revised from time to time.

In view of this fact, the Committee trust that for a time a reasonable degree of latitude will be allowed by engineers in the interpretation of the clauses.

The Committee will be glad to receive expressions of opinion from those interested in this matter, and to be advised of individual experience with material made in accordance with the standard specifications.

It is proposed to next proceed with the preparation of the third section—that relating to silicious and silica bricks.

SPECIFICATION.

Preamble.

For the purpose of classification, it is understood that this specification applies generally to material made from fire-clay containing approximately not more than 75 per cent. of silica. It is known, however, that there are in certain areas fire-clays containing as much as 80 per cent. silica; and material made from such clays shall be considered to conform to this specification if it passes the tests herein specified.

Refractoriness.

Clause 1.—Two grades of material are covered by the specification.

(1) Material which shows no sign of fusion when heated to a temperature of not less than Seger cone 30 (about 1670° C.).

(2) Material which shows no sign of fusion when heated to a temperature of not less than Seger cone 26 (about 1580° C.).

The test shall be carried out in an oxidizing atmosphere, the temperature of the furnace being increased at the rate of about 50° C. per five minutes.

[Note.—The new scale of Seger cones printed herein is to be used.]

Chemical Analysis.

Clause 2.—A complete chemical analysis of the material is to be provided when required by the engineer (or purchaser), for his personal information only.

Surfaces and Texture.

Clause 3.—The material shall be evenly burnt throughout, and the texture regular, containing no holes or flaws. All surfaces shall be reasonably true and free from flaws or winding.

Contraction or Expansion.

Clause 4.—A test-piece when heated to a temperature of Seger cone 12 for two hours shall not show more than the following linear contraction or expansion:

No. 1 grade, 0·75 per cent.
No. 2 grade, 1 per cent.

The test-piece shall be 5 to 6 centimetres long; the ends being ground flat, and the contraction measured by means of Vernier callipers reading to 0·1 mm.—a suitable mark being made on the test-piece, so that the callipers may be placed in the same position before and after firing.

Variations from Measurements.

Clause 5.—In the case of ordinary bricks, 9 in. by 4½ in. by 3 in. or 2½ in. thick, there shall not be more than ± 1½ per cent. variation in length, nor more than ± 2½ per cent. variation in width or thickness; and in all cases the bricks shall work out their own bond, with not more than ⅛-inch allowance for joint. In the case of special bricks, blocks, or tiles, there shall not be more than ± 2 per cent. variation from any of the specified dimensions.

Crushing Strength.

Clause 6.—The material shall be capable of withstanding a crushing strain of not less than 1800 lbs. per square inch, when applied in the manner set out in the appendix.

Cement Clay.

Clause 7.—This shall be machine ground, and at the discretion of the manufacturer may contain a suitable percentage of fine grog. But in all cases the cement clay shall be quite suitable for the purpose of binding together the bricks, blocks, or tiles for which it is supplied, and shall be capable of withstanding the same test for refractoriness.

Marking of Material.

Clause 8.—All bricks, blocks, or tiles shall be distinctly marked by means of a figure 1 or 2 (not less than 1-inch long) stamped on them to indicate the grade to which they belong, and it shall be understood that any material not so marked is ungraded, and is not purchased in accordance with the terms of this specification.

Inspection and Testing.

Clause 9.—The engineer (or purchaser), or his agreed representative, shall have access to the works of the maker at any reasonable time, and shall be at liberty to inspect the manufacture at any stage, and to reject any material which does not conform to the terms of this specification. Pieces may be selected for the purpose of testing, either before or after delivery; but in either case a representative of the maker shall, if he choose, be present when such selection is made, and shall be supplied with a similar piece of the material to that taken for the purpose of testing.

If the engineer (or purchaser) and the maker are not prepared to accept each other's tests, they shall agree to submit the samples for testing to an independent authority to be mutually agreed upon; and the engineer (or purchaser) reserves to himself the right, if the material does not conform to the tests laid down in the specification, to reject any or all the material in the consignment from which the test-pieces were taken.

The cost of these independent tests and of any bricks, blocks, or tiles damaged before delivery for obtaining test-pieces, shall be equally divided between the purchaser and the maker if the test proves satisfactory; and if unsatisfactory, such cost, and that for all other subsequent tests required on this account from the same consignment, shall be borne by the makers.

The cost of any tests or of any material damaged for the purpose of obtaining test-pieces after delivery shall be borne by the purchaser in the event of the test being satisfactory, and if unsatisfactory by the manufacturer, in a similar manner to that specified for the tests prior to delivery.

Appendix and Notes.

Refractoriness.

Clause 1.—The Deville furnace, although useful for comparative tests in refractoriness, is not altogether suitable for carrying out those specified in this clause, for which a compressed air-gas furnace of the Méker type, or Hirsch's electric furnace, is recommended. The latter can be obtained from Messrs. Gallenkamps, of London; the former from the Scientific Instrument Company, of Cambridge. The gas-furnace will require an air-pressure of at least 10 lbs. per square inch; and for the electric furnace a current of approximately 90 volts and 90 amps, with a slightly higher voltage at the start, has been found, by means of a carefully standardized Wanner pyrometer, to be sufficient.

Two or more tests are generally required with an unknown material.

A preliminary trial is first made with a piece of the material chipped into the approximate form of a cone. This should be cemented on to a refractory disc or slab with a mixture of alumina and best china clay, together with Seger cones 28, 30, and 32 (small size). These cones are selected because they cover the range of first-grade clays. Best china clay fuses between cones 35 and 36; and all British fire-clays fall below this point. If cones 28 and 30 fall, the furnace should be cooled, and the material under investigation examined. If it exhibits no sign of fusion, the trial should be repeated with cones 31, 32, and 33. When cone 32 squats, the piece should be again examined; and if it shows signs of fusion, the trial should be repeated with cones, 30, 31, and 32. By this method of approximation, it is possible to decide whether the piece vitrified between cones 30 and 31 or between cones 31 and 32. A similar method should be adopted when testing second-grade material.

It should be noted that clays and related materials have no sharply defined "melting point;" and the definition of refractoriness here adopted refers to the temperature at which the angular edges of the material under investigation begin to lose their angularity when heated under the conditions stated.

Softening Points of Seger Cones.

Cone No.	Cent.	Fahr.	Cone No.	Cent.	Fahr.
022	600	1112	9	1280	2336
021	650	1202	10	1300	2372
020	670	1238	11	1320	2408
019	690	1274	12	1350	2462
018	710	1310	13	1380	2516
017	730	1346	14	1410	2570
016	750	1382	15	1435	2615
015a	790	1454	16	1460	2660
014a	815	1499	17	1480	2696
013a	835	1535	18	1500	2732
012a	855	1571	19	1520	2768
011a	880	1616	20	1530	2786
010a	900	1652	26	1580	2876
09a	920	1688	27	1610	2930
08a	940	1724	28	1630	2966
07a	960	1760	29	1650	3002
06a	980	1796	30	1670	3038
05a	1000	1832	31	1690	3074
04a	1020	1868	32	1710	3110
03a	1040	1904	33	1730	3146
02a	1060	1940	34	1750	3182
01a	1080	1976	35	1770	3218
1a	1100	2012	36	1790	3254
2a	1120	2048	37	1825	3317
3a	1140	2084	38	1850	3362
4a	1160	2120	39	1880	3416
5a	1180	2156	40	1920	3488
6a	1200	2192	41	1960	3560
7	1230	2246	42	2000	3632
8	1250	2282	—	—	—

Chemical Analysis.

Clause 2.—The silica should be determined by two evaporations with an intervening filtration; and the alumina, lime, and magne-

sia, by two precipitations. The amount of titanic oxide should be indicated, and not confused with alumina and iron. The potash and soda should be separately determined.

LINEAR CONTRACTION OR EXPANSION.

Clause 4.—The term "linear contraction or expansion" indicates the percentage change in length (and by a simple calculation the change in volume) which occurs when a piece is fired under the conditions stated. Consequently the linear contraction or expansion is—

$$\frac{\text{Change in length} \times 100}{\text{Original length of piece}}$$

A carborundum wheel may be used for grinding the ends of the test-pieces flat; and a mark should be made across the slab with a steel file. One of the Méker gas furnaces, with blast if necessary, may be used for carrying out the test. The temperature is difficult to regulate without a pyrometer. The test-piece should be supported horizontally, and fired along with cones 11, 12, and 13.

CRUSHING STRENGTH.

Clause 6.—The machine required for the measurement of the crushing strength is so expensive that it will generally be necessary to have the tests carried out in a suitably equipped laboratory. The method to be employed is often determined by the capacity of the machine. The measurements on which the datum stated in the specification was based, were made in a large Avery machine with whole bricks placed with their long side vertical between the jaws of the machine, giving a vertical thrust. The most important factors requiring attention are:

(1) The two ends of the brick which come in contact with the jaws of the machine must be either ground or sawn flat and parallel, so as to receive a vertical thrust.

(2) An average of not less than three bricks must be used, because flaws, &c., may give an abnormal result, which might not be detected if only one brick be used.

[NOTE.—*Any information with regard to the specification may be obtained from the Honorary Secretary of the Refractory Materials Committee, Mr.* F. J. BYWATER, *Saltley Gas-Works, Birmingham.*]

June, 1911.

Mr. J. W. HELPS (Croydon) proposed that the report be taken as read and approved. He said this was the second section dealing with the matter which the Committee had been from time to time considering. The first section dealt with the specification for the retorts; the second, with fire-bricks generally. He thought the report would show that the Committee had done a great deal of good work, which would assist the industry greatly in the future. The Sub-Committee was composed not only of members of the Committee, but also of representatives of the Society of British Gas Industries. These two bodies had worked splendidly together, and had evolved something which would be of great use to the industry, and would remove from the manufacturers of fire-brick materials the reproach that they could not make an article which was capable of giving such satisfaction as the one made abroad.

Dr. H. G. COLMAN (London) seconded the motion. He said it would be of great help to the Committee in their work if those who had experience of the difficulties connected with drawing-up a suitable specification would communicate with them. He wished to corroborate what Mr. Helps said with regard to the hearty manner in which the representatives of the Society of British Gas Industries had worked with the Institution in framing a specification which would carry out what was desired by both parties—viz., that they should have a good material for all the purposes required.

Mr. HELPS said he had forgotten to refer to the valuable work done by Mr. Bywater, which was highly appreciated by the Committee.

Mr. G. H. TIMMIS (Timmis and Co., of Stourbridge) said he accepted the specification in the sense in which it had been drawn up. The fire-brick makers were quite prepared to place themselves in the hands of the engineers, if they on their part would give them credit for doing the best they could in the circumstances. He was glad to have the opportunity of expressing the appreciation of the fire-brick makers for the manner in which the Institution had allowed them to co-operate with them so fully in drawing-up the specification.

The PRESIDENT, in putting the motion for the adoption of the report, said the Committee had gone into the subject thoroughly, and were now reaping the benefits of their labours. Mr. Bywater had done a great deal of useful work on the Committee. Their thanks were not only due to the Committee, but to the Society of British Gas Industries for their assistance.

The motion was carried unanimously.

Reading of Communications.

The reading of papers was then proceeded with. They were taken in the following order:—

Tuesday.—"The Dessau Vertical Retorts at Sunderland," by Mr. CHARLES DRU DRURY. "The Woodall-Duckham System of Vertical Retorts," by Mr. JOHN P. LEATHER. "The Scientific Carbonization of Coal," by Mr. J. G. NEWBIGGING.

Wednesday.—"The Choice of a Carbonizing System," by Mr. P. C. HOLMES HUNT.

Thursday.—"The Uses of High-Pressure Gas for Industrial Heating Purposes," by Mr. E. W. SMITH, M.Sc. "Public Lighting," by Mr. S. B. LANGLANDS. "Modernizing a Medium-Sized Undertaking," by Mr. C. F. BROADHEAD. "Notes on the Corrosion of Service-Pipes," by Mr. JAMES M'LEOD. "Some Aspects of Gas Supply in a South American City," by Mr. BERNARD F. BROWNE.

THE BENEVOLENT FUND.

On Wednesday morning, the annual meeting of the donors and subscribers to this fund was held. A report of the proceedings will be found on page 850.

The Gift of the German Association.

The PRESIDENT, on Wednesday morning, referred to the handsome gift which the Institution had received from the German Association of Gas and Water Engineers, which was announced at the luncheon the previous day, and said that perhaps it would be appropriate if the subject were put formally before the meeting. He read the letter which accompanied the gift [see p. 849], and said he thought the members would agree with him that it was a great compliment which the German Association had paid their Institution. They reciprocated most gladly the kindly feelings and expressions which their German brethren had sent in the letter on behalf of their Association. As desired by them, he had much pleasure in accepting the gift from their Committee of Management, and handing it on to the Institution. He hoped that it would be long used by the Presidents, and that there would never be any need to do anything but use it in the way expressed in the letter.

Mr. J. W. HELPS (Croydon) proposed that the President and the Hon. Secretary indite a letter to be sent to the German Association, that could be read at their annual meeting which they would be holding soon, thanking them heartily for their kind expressions, and telling them how thoroughly the members of the Institution appreciated their good-will. He was sure they must all be agreed that this interchange of good-will at the present moment was for the benefit of the gas industry, and would also be for the good of the greater interest of the peace of nations throughout the world. He thought a formal letter of thanks should be sent to the President of the German Association, so that it might be read at their forthcoming meeting.

Mr. R. G. SHADBOLT (Grantham) said he had much pleasure in seconding the motion. He thought the compliment which had been paid to them by their German friends was the finest that any body of gas engineers could pay to another body. He hoped one and all of the members of the Institution felt that an expression of their feelings as proposed was the right thing for them.

The PRESIDENT considered that he need scarcely put the motion to the meeting; but he formally asked if they were all agreed.

The motion was adopted with great cordiality.

The New Officers.

The PRESIDENT announced the result of the election of office-bearers for the current year as follows:—

President.—Mr. Robert G. Shadbolt, of Grantham.

Vice-President.—Mr. Edward Allen, of Liverpool. [Mr. J. Ferguson Bell, of Derby, is Senior Vice-President.]

New Ordinary Members of Council.—Mr. James M'Leod, of

Greenock; Mr. Robert Watson, of Doncaster; Mr. Harold W. Woodall, of Bournemouth; and Mr. John Young, of Hull.

Auditors.—Mr. J. L. Chapman and Mr. Ernest W. Drew.

Hon. Secretary.—Mr. S. Y. Shoubridge.

New Members Elected.

The following candidates for membership of the Institution were elected.

MEMBERS.

Bloor, Harold Edgar, Engineer, Corporation Gas-Works, Carlisle.

Broughton, Joseph Thomas, Manager, Corporation Gas-Works, Congleton.

Caton, William James, Assistant-Engineer, Derby Gas Company.

Collett, Harold Harvey, Works Manager, Ayres Quay Gas-Works, Sunderland.

Copp, Walter Lewis, Manager, Axminster and Ottery St. Mary Gas-Works.

Dunn, George Foster, Secretary and Manager, Blandford Gas Company.

Fyffe, Andrew Morton, Manager, Corporation Gas-Works, Nelson.

Geer, Leonard J. C., Manager, South Oxfordshire Water and Gas Company, Goring-on-Thames.

Harrison, John Frederick, Chief Assistant, Glasgow Corporation Gas Department.

Jonas, William, Manager, Gas-Works, Earby, Lancs.

Kenshole, James Edmund, Engineer and General Manager, Merthyr Tydfil Gas-Works.

Livesey, Frank, Engineer and General Manager, Maidstone Gas Company.

Shadbolt, Walter, Manager, Llandudno Gas-Works.

Stokes, Albert, Manager, Sales and Distribution Department, South Metropolitan Gas Company.

Taylor, John, Manager, Coleraine Gas and Water Works.

Tobey, Reginald Seymour, Engineer and Secretary, Horley District Gas Company.

Valon, William M'Intosh, Engineer and Manager, Corporation Gas and Electricity Works, Stafford.

Walmsley, Percy Dawson, Gas and Water Engineer, Wombwell Urban District Council.

White, Thomas Herbert, Engineer and Managing-Director, Cwmbran and Pontnewydd Gas Company.

Wilson, William, Manager, Corporation Gas-Works, Falkirk.

Wynne, James William, Manager, Sandy Gas-Works, Beds.

ASSOCIATE MEMBERS.

Canning, Thomas Francis, Assistant-Engineer and Manager, Ilford Gas Company.

Chester, William Harold Arthur, Assistant-Engineer, Corporation Gas-Works, Nottingham.

Green, Herbert, Manager and Secretary, Stamford and St. Martin's Gas Company.

Gribble, Godfrey Maurice, Manager, Kirkby-in-Ashfield Gas-Works.

Griffin, William, General Manager and Secretary, Folkestone Gas Company.

Halkett, Ralph, Assistant Superintendent, Gas-Mains and Distribution Department, Leeds.

Harman, Edwin Hazzard, an Assistant-Engineer at the Beckton Works of the Gaslight and Coke Company.

Howie, William Arthur, Assistant-Manager, South Shields Gas Company.

Meade, Alwyne, Assistant to Resident Engineer at the Poplar Works of the Commercial Gas Company.

Mortlock, Frederick Charles, Manager, Whitland Gas Company.

Preedy, Louis Cecil Cotes, Assistant to the Engineer of the Hornsey Gas Company.

Saville, Thomas Walter, Manager and Secretary, Stone Gas Company.

Scruton, Arthur G., Manager, Witney Gas Company.

Smith, Alfred George, Superintendent, Liverpool Corporation Gas and Lighting Department.

Staley, Ralph, Engineering Assistant, Midland Railway Gas Department, Derby.

Stears, Samuel Morley, Superintendent, Belfast Gas-Works.

Thornton, Timothy, Manager and Secretary, Rowley Regis and Blackheath Gas Company.

Wedd, Francis Herbert, Assistant at the Ilford Gas-Works.

Wilson, John, Assistant-Manager, Corporation Gas-Works, Falkirk.

Yorke, Edward George, Assistant-Manager, Littlehampton Gas Company.

Honorary Members.

The PRESIDENT moved the election as Honorary Members of the President of the Société Technique de l'Industrie du Gaz en France, and the President of the German Association of Gas and Water Engineers. There was not the slightest doubt, he said, that having these gentlemen as Honorary Members helped to promote good feeling between their Associations; and everything which tended to do this ought to be encouraged, and should meet with favour.

Mr. S. GLOVER (St. Helens) had very great pleasure in seconding the President's proposal. He thought it was an honour to the gentlemen named, and that they took sufficient interest in it to deem it an honour to themselves that they were made members of the Institution.

The motion was agreed to with great cordiality.

Votes of Thanks.

Mr. E. ALLEN (Liverpool) said that the resolution which he had the honour to propose was that they tender their sincere thanks to the Lord Provost, the Hon. A. M'Innes Shaw, and to Mrs. Shaw, to Bailie Paxton, the Convener of the Gas Committee, and Mrs. Paxton, and to the members of the Gas Committee, for their hospitable welcome and kindness in connection with all the arrangements for the meeting. They were all agreed on this vote. It had been an exceptional time. He could hardly conceive it possible they should have better entertainment or more kindness.

Mr. J. FERGUSON BELL (Derby) was quite sure that it needed no words of his to commend the resolution. They remembered with much pleasure and interest that the Lord Provost and members of the Gas Committee on Tuesday morning gave them a very cordial welcome to the important City of Glasgow. When the Convener of the Gas Committee (Bailie Paxton) in London last year gave them a pressing invitation to Glasgow, he promised that he would make their visit as interesting and pleasant as possible; and he (Mr. Bell) was sure he voiced the opinions of the whole of the members of the Institution when he said that the promise had been carried out in a right royal manner. They felt themselves under a deep debt of obligation to the Lord Provost, the members of the Gas Committee, and of the Corporation, for the way they had been entertained, and for all the kindness they had received. He cordially seconded the resolution.

The motion was agreed to.

Mr. J. W. MORRISON (Sheffield) submitted that they had had good fortune in having had such a palatial building given to them to meet in; and he proposed that their best thanks be tendered to the Council of the Glasgow and West of Scotland Technical College for their kindness in granting the use of their Examination Hall for the meetings of the Institution.

Mr. J. YOUNG (Hull) had pleasure in seconding.

The PRESIDENT explained that they had arranged to meet in the very fine buildings of the Association of Engineers and Shipbuilders; but when the replies came in, it was found that the hall there would not be large enough for them. He then saw the Secretary of the Technical College, who laid the matter before the Council; and the use of the College was granted at once, and with the greatest good-will, both for their meetings and for the lecture.

The motion was agreed to.

Mr. J. W. HELPS (Croydon) said he felt it a great honour to be entrusted with the proposal in the next resolution—that the thanks of the members, both those present and those absent, be given to the President for the skilful way in which he had steered their ship during the past year, and the manner in which he had conducted the meetings in Glasgow. He should also include in the resolution the name of Mrs. Wilson, the wife of their President. They all knew how splendidly she had assisted her husband in ministering to their comforts during their stay in Glasgow. It was also a great pleasure to him to propose the resolution. He had known Mr. Wilson for a great many years—perhaps Mr. Wilson would not care if he mentioned how many. It was not in a gas-works that they met first; it was on a cricket field. He had always noted the cordial way Mr. Wilson had been received in the body of gas managers. He (Mr. Helps) was sure they were all pleased

to observe the position he held, not only among his own people, but in the hearts of the Gas Committee. It had been a magnificent meeting. Nothing could have been better. Although it had been stated in the course of their discussions that Glasgow had done nothing in the high-pressure system of supplying gas, he thought they would agree with him that it was not because the Engineer was at all indifferent to the matter. Members of the Council knew how well Mr. Wilson had conducted business in the Council Chamber; and they had all seen how well he had done his duty in the chair at the meetings of the Institution. They wished him good health and prosperity.

Mr. A. WADDELL (Dunfermline) seconded the motion so well put by Mr. Helps.

The proposition was adopted by acclamation.

The PRESIDENT (who was warmly applauded on rising) said it had been a great pleasure to him to be in the position he had occupied during the past year. While saying so, he recognized that he might have done a great deal more. He did what he could; but, being so far from London, it was somewhat difficult for him to give the amount of personal attention that one nearer to the headquarters of the Institution might have done. But with a Secretary like Mr. Dunn, this difficulty was got over fairly well. He hoped that all the readers of papers would excuse him for the manner he tried to carry through the business. He wished that they should get through in something like time, without having recourse to the taking of papers as read. When a gentleman went to the trouble of preparing a paper, he (Mr. Wilson) did not like to take it as read, if it could possibly be read. He wished to thank them, and also Mr. Helps, for the kind manner they had spoken of him. Mr. Helps was an old friend of his. As he said, they played cricket together—perhaps he had better not say how long ago. He hoped that none of them would ever regret having come to Glasgow for the present meeting. He would, he might add, have the greatest pleasure in conveying their thanks to his wife.

Mr. A. F. BROWNE (London) was privileged, he considered, in being asked to propose a vote of thanks to the Council of the Institution, and to the Hon. Secretary, for their efforts on behalf of the members, on behalf of the gas industry, and on behalf of the consumers of gas, during the past year. The Council had embodied the results of their labours in the report which had been presented to the Institution, and which had been received and adopted by the members with but little criticism, and that of the very friendliest. They knew that the Council were busily engaged in the investigation of problems of the greatest importance and urgency in the present day—both from the point of view of themselves, as gas engineers, and of those engaged in the industry, and especially for the benefit and advantage of the consumers of gas. There was an earnest desire on the part of the members of the Council to do their best for the industry. There was ample ability in the Council to do the work; and there was ample activity to carry it through. If there was anything wanting, it was that which was usually wanting—some increase in the funds of the Institution. He was glad to see that the Council had hit upon the excellent plan of the division of labour, in the carrying on of their work, in their having formed Committees and Sub-Committees. If, he continued, there was a member of their industry who was conspicuous for modesty, it was their Honorary Secretary. There was no man among them better fitted, by his varied knowledge and experience of matters concerning gas engineering, by his wide knowledge of men, and by his diplomatic ability, to occupy the high and most important position which Mr. Shoubridge filled with such advantage to them all. He felt sure Mr. Shoubridge was looked upon by all of them, and by those who were especially privileged to know him somewhat more intimately, with feelings of affectionate regard. To him, their thanks were heartily tendered. He (Mr. Browne) might say that Mr. Shoubridge's services, his advice, and his presence on the Council, were of the utmost value to all, from the President downwards.

Mr. ROBERT WATSON (Doncaster) seconded. He said he had seen something more than previously of the volume of the work of the Council; and the work they were doing was certainly excellent, and was likely to be of considerable interest to them and to the gas industry at large.

The motion was agreed to.

Mr. R. G. SHADBOLT said that, as a Vice-President of the Institution, he had great pleasure in thanking them for their thanks for the work that had been done. The work of the Council was done in practically water-tight compartments. The work had been increasing to such an extent that the President, who was *ex officio* on all Committees, could not possibly keep in touch with every Committee. Each year, as the President had told them, saw an increase in the work which devolved upon the Council; and each succeeding year would see greater increases, so far as one could humanly imagine. He thought, therefore, this was one point upon which the organization of the Institution would require very radical changes, apart from the broadening of the basis upon which their members were now admitted. He would not feel justified in saying that they had been hard-worked. Might he say they never had a Council more in touch and more alive to the interests and the wishes of the general body of the members, than they had had during the past year? They had endeavoured to carry out their duties in the very best possible way; and if the results had not always appealed with satisfaction to the members of the Institution, they might depend upon it that it had not been for want of aim, of energy, or of ability.

Mr. SHOUBRIDGE thanked the members very heartily indeed for the kind way in which he had been spoken of. He was very conscious indeed of his own shortcomings. He did not know why they thanked him at all. They had put him into a very honourable and enjoyable position, in connection with the Institution; and he did not deserve any thanks whatever. Really their thanks ought not to be given to him at all, but to the Secretary, Mr. Dunn. Presidents came and Presidents went, but Secretaries did not; and everyone who had been in office knew how very thoroughly the Secretary had done his work. He (Mr. Shoubridge) saw him going and coming to the office by day; and he often saw him there at hours when he should have been at home. He was sure that no thanks they could give to Mr. Dunn would adequately convey to him their sense of the obligation they were under to him for what he had done. He had therefore the greatest pleasure in moving that their heartiest thanks be given to Mr. Dunn for his services during the past year.

The PRESIDENT said that, as one of the Presidents who came and who would soon be gone, he would like to second Mr. Shoubridge's motion. He had been on the Council for a good many years now, and he had come into close relationship with Mr. Dunn. He cordially agreed that Mr. Dunn was well entitled to their heartiest thanks at all times. He did his work earnestly, and he did it promptly, attending to everything down to the smallest details.

Mr. J. C. BELTON (Chester), as an ordinary member of the Institution, and one who had nothing to do with the Council, expressed the sense which the ordinary members had of the kindness, the courtesy, and the attention which they always received from Mr. Dunn.

Mr. DUNN said he thanked the members exceedingly for their great kindness in proposing this vote. He could assure them that it was a great pleasure to work for the Institution, because everyone took such an interest in the work—a work that was very rapidly increasing. He should always do what he could to help forward the Institution.

Mr. ALLEN proposed a vote of thanks to the Research Committees, the Authors of Papers, the Scrutineers, and the Auditors. It was an "omnibus" resolution, he said, and would make them feel that, at all events, their consciences were relieved, and that they had done their duty by all those mentioned.

Mr. D. IRVING (Bristol) seconded; and the motion was adopted.

Mr. A. E. BROADBERRY (Tottenham) responded on behalf of this "somewhat comprehensive" vote. The Research Committees were, he said, very glad that they had been able to make so much progress in their work. On behalf of the authors of papers, he should like to say that they felt that, to some extent, they ought to express regret for having to curtail and clip their papers to the extent that they had. Perhaps in future years the number of papers might be somewhat limited, so that the discussions upon them could be more complete; and to this end, perhaps, the Council would take note of his suggestion that a synopsis of the papers should be published with the notice of the meeting, and in the Technical Press, beforehand—not a synopsis which should be complete in every detail, but one that would be simply an index of the arguments that were going to be used. He believed that this would be better for the discussion, and beneficial to both hearers and readers of papers. On behalf of the authors, he begged to thank the meeting for the attention they had paid, and the patient

hearing they had given, to them, and for the helpful contributions made in the discussions. The Scrutineers and the Auditors were also very gratified indeed to be included in the vote of thanks.

Election of Office Bearers.

The PRESIDENT submitted the report of the Scrutineers giving the result of the elections—see p. 845. He had great pleasure indeed in stating that Mr. Shadbolt had been elected President for the coming year. He wished Mr. Shadbolt as pleasant a year as he had had. He could promise him plenty of work. There was plenty of work in front of him, and no doubt he would carry it through, more efficiently, perhaps, than he (Mr. Wilson) had done. Mr. Shadbolt had had more experience in these matters than many of them ; and he was in close touch with the men in the Midlands, where there was so large a number within so small an area. In this way he would be within the heart of things, and would, perhaps, be able to get better results out of the various propositions—especially that in regard to Publicity—than some of them who (he was going to say, lived on the fringe of civilization, but he could not say that in Glasgow) lived further away from centres where there were many gas men congregated. He had very great pleasure indeed in intimating to Mr. Shadbolt that he had been elected President of the Institution for the year, and in asking him to accept office.

Mr. SHADBOLT (who was received with applause) said he scarcely knew how to express his feelings. Mr. Wilson, in his usual modest style, in making the announcement of the result of the ballot, had endeavoured, to some extent, to depreciate his own geographical position ; but he assured them, from his own knowledge of the work of the Council and of the Institution, that it was not always a disadvantage to be far removed from the centre. Possibly no President during the last few years had benefited more from this particular geographical disability than had their present President, Mr. Wilson, of Glasgow. As they had been already reminded, Presidents come and Presidents go ; and now, having been selected for the highest office to which it was in the power of the Institution to elect any member, might he, having "no axe to grind," make one suggestion, with regard to the report of the Scrutineers ? He had several times been on the purgatorial grid (might he say), as a candidate for a seat on the Council, as a candidate for the Vice-Presidency, and finally as a candidate for the Presidency ; and it seemed to him absurd that they should keep men during at least two days without a knowledge of the result of the ballot. If it met with the approval of the members generally, as soon as the Scrutineers had determined the result of the ballot, he thought this result should be posted up, for all and every member to see at once. Those who did not care were not the kind of men who were, as a rule, selected for office among them ; those who did care were, generally speaking, the men who cared the most. He thanked the members generally for the great honour they had done him—the greatest honour, he believed, which could be placed upon any individual member of the gas industry throughout the wide world ; and in thanking them, might he remind them that in placing him in the chair, they were also placing on themselves a certain amount of responsibility, which was to support him, and to support the Vice-Presidents and Council, throughout the year, on any and every occasion that might arise ? If this were done, he had not the slightest doubt that the coming year would see a thoroughly great advance in gas affairs—as great as in any year which had preceded it.

The PRESIDENT remarked that what Mr. Shadbolt had referred to was certainly done in a great many instances. He would be able to give effect to it next year ; and it would perhaps be a pleasant innovation. He thought he could assure Mr. Shadbolt of the heartiest support from his Vice-Presidents, his Council, and the members, in regard to all the work which would be before him. Continuing, he said that the next election he had to announce was that of Vice-President. Mr. Edward Allen had been appointed. This was an election which would give the greatest satisfaction to everyone ; and he hoped it would also give great satisfaction to Mr. Allen himself. He had done a great deal for the gas industry in the past ; and on the Council he had done a great deal of good work. Personally he was very pleased to see him put into this position. He thought he was the right man in the right place. He also wished him every success in his new office.

Mr. ALLEN thanked the President for the kind way in which he had alluded to him, and the members for the great honour they had conferred upon him. He accepted the office with an even increased desire to serve the Institution and the industry.

The PRESIDENT then announced the result of the ballot in the case of the other offices. He also intimated that those who had been nominated as Members and Associate Members had all been elected. [The list appears on p. 849.]

Next Place of Meeting.

The PRESIDENT said the only other matter remaining to be disposed of was the place of meeting for next year.

Mr. SHADBOLT said that if he were to invite them to meet a year hence at Grantham, they would think that something was wrong with his mental faculties, because they had not the accommodation, either in regard to hotels or to a suitable meeting place. Consequently, if any gentleman present was prepared to move a resolution with respect to the next meeting, he would much prefer it.

Mr. C. F. BOTLEY (Hastings) moved that the meeting be held in London.

Mr. E. A. HARMAN (Huddersfield) seconded the resolution.

Mr. GEORGE HELPS (Nuneaton) moved that the meeting be held either in Manchester or Birmingham ; and on being required to choose one or other town, he selected the latter.

This was not seconded.

Mr. J. C. BELTON (Chester) referred to London as the most easily accessible centre in which to hold their meetings ; and although they did occasionally—once in two or three years—go to the Provinces, the present occasion was not a suitable one, in his opinion, for departure from their usual practice. They had had an exceptionally delightful meeting in Glasgow, for which they were all grateful.

It was then agreed unanimously that the meeting next year should be held in London.

The PRESIDENT said they had now come to the end of a most agreeable and successful meeting. He did not think he need say anything more than just to thank all the members for their close attendance upon the meetings there.

The proceedings terminated shortly after two o'clock in the afternoon.

A Range of Gas-Cooking Stoves.

THE GLASGOW CORPORATION GAS SHOW-ROOMS IN SAUCHIEHALL STREET.

LUNCHEON BY THE CORPORATION.

The Corporation of Glasgow invited the members and their friends to luncheon in the City Chambers on Tuesday afternoon. The Banqueting Hall, in which many similar functions have been held, was too small for the assemblage, which numbered about 800, and was the largest gathering of the kind which the Corporation have yet entertained. There was, in consequence, an "overflow meeting" in an upper room. At the principal table in the Banqueting Hall, the chair was taken by Lord Provost A. M'Innes Shaw, who had on his right hand Mr. Alex. Wilson, Mr. Shoubridge, Mr. J. W. Helps, Councillor Walker (Glasgow), Judge Bryson (Leith), Mr. Thomas Glover, Professor Gray (Glasgow), Mr. D. Irving, Mr. W. K. Herring, Mr. G. R. Hislop, Mr. Chapman, Mr. Clare, and Mr. J. G. Newbigging; and on his left Bailie Paxton, Mr. R. G. Shadbolt, Sir D. M'Allister (the Principal of Glasgow University), Mr. E. Allen, ex-Bailie Calderwood, Councillor Geldard, Professor Smithells, Treasurer Graham, Mr. W. Doig Gibb, and Mr. John West.

The LORD PROVOST, in proposing the toast of "The King," said this week the Corporation of Glasgow were entertaining about 150,000 school children, and were presenting each of them with a Coronation medal, driving them to the Exhibition in Corporation cars, and providing them with luncheon, giving a firework display, and making them happy and merry. They were also entertaining quite a large number of old people at a dinner on the day before the Coronation. They were also holding other entertainments of a suitable nature; and on the Sunday following the Coronation they were to have a church service. Altogether, they were doing the thing in quite a Scotch fashion, finishing up in the Kirk.

The toast was duly honoured, as was also that of "The Queen and Other Members of the Royal Family."

The LORD PROVOST then gave the toast of "Our Visitors, the Members of the Institution of Gas Engineers." In doing so, he said he desired to express the pleasure that it gave his colleagues and himself to receive there so distinguished and representative a gathering. It was twenty-four years since they last met in Glasgow, under the presidency of their late Gas Engineer, Mr. William Foulis. Since that time, great changes had taken place, not only in the utilization of gas for domestic and industrial purposes, but also in its manufacture and adaptation. As a factor in the solution of one of the most clamant problems of modern life, gas was destined to play a very important part. He referred, of course, to the pollution of the air. The smoke nuisance had engaged the attention of every industrial community; and they were realizing more and more that its abolition depended upon a more universal utilization of gas, The Corporation of Glasgow had not been blind to their responsibilities in this matter, and, as the result of exhibitions and lectures, demonstrating the utility and efficacy of gas in a variety of domestic and trading directions, the public were gradually awaking to the possibilities of this medium in hitherto undreamt-of spheres. Cleanliness and economy were only two results which the more universal employment of gas secured. In the consideration of such problems, they looked to the Institution of Gas Engineers for much useful guidance and help. At the annual conference, views were expounded, methods were compared, criticisms were offered, from a variety of points of view; and the ultimate result was to the advantage of the populous districts of the country. When the members of the German Association of Gas and Water Engineers visited Glasgow in October last, reference was frequently made to the fact that Scotland gave to the world the inventor of gas, in the person of William Murdoch, and that Germany had done much to perfect and develop subsequent processes and methods in the science of illumination. He thought, however, that Great Britain did not lag very far behind her Continental neighbour in the great department of gas engineering. Every year they were finding it necessary to make improvements in machinery and in the process of carbonization, as well as in the development of public and private lighting. So long as the municipalities of Great Britain were advised by gentlemen of the position, experience, and genius of the guests of the Corporation that afternoon, they need not fear that they would lose their place in the van of industrial and commercial progress and enlightenment. He had referred to the visit of the German Gas and Water Engineers; and before asking those present to rise to drink to the toast, he would like to say that their friends from Germany—remembering that this meeting was taking place in Glasgow that day—had sent the following letter, which he took the opportunity of reading. It was not very long, but it was most interesting:—

Karlsruhe, June 7, 1911.

At the end of the Institution year, the German Association of Gas and Water Engineers remember with pleasure and gratitude the visit made by eighty of our members to the British Brother Association, the Institution of Gas Engineers, in October, 1910. We have acquired valuable knowledge in the department of our professional activity from the brilliantly conducted gas-works of London, Edinburgh, and Glasgow, which take a high rank in technical efficiency. The days we were together showed how strong were the feelings of friendly relationship between our two great technical Societies; and they emphasized, also, the friendly relationship between the citizens of our two great nations. We separated with the firm resolve to contribute our part to the further exchange of technical knowledge, and to the ever-growing good understanding between our nations.

At festive gatherings we have become acquainted with the British custom of striking the table with a hammer to call for silence for the expression of serious, festive, friendly, or humorous ideas. So, when we endeavour to give formal expression to our thanks for all the kindness offered us by the Institution of Gas Engineers, by sending a President's hammer, with plate, made by the Karlsruhe artist, Professor Hoffacker, it is our wish that the hammer may always secure attention for words that will contribute to the peaceful greatness of the nation, to the advance of our great gas industry, which is a benefit to all, and will also awaken the recollection of friendly relations with our German Association of Gas and Water Engineers.

On behalf of this Association, we request Mr. Alex. Wilson, the esteemed President of the Institution, to accept this offering, and to hand it to the Institution of Gas Engineers at their meeting, along with our greetings and our sincere thanks.

Signed, by order of the German Association of Gas and Water Engineers, by the Committee of Management,

H. PRENGER, President,
HANS BUNTE, Honorary Member of Committee,
KARL BUNTE, General Secretary.

He took the opportunity of introducing the letter at this time; and he was quite sure they all appreciated very much the kindly thought of their German friends in sending it at the appropriate moment when they were met there together. He coupled with the toast the name of his friend Mr. Wilson, the esteemed President of the Association and their respected Gas Engineer.

The reading of the letter was warmly applauded; and the toast was similarly honoured.

The PRESIDENT remarked that, in rising to respond to the toast so ably proposed by the Lord Provost, he felt that he only voiced the sentiments of all his colleagues, when he said that his first word must be one of thanks for the hearty welcome they had had extended to them, and also for the hospitable manner in which they had been received. In connection with the grand present from their German brothers in gas engineering, he thought that it gave an added charm to the gift to have had it presented by the Lord Provost of Glasgow. Their German friends, as usual, did the thing in a very methodical and splendid way. They had timed their gift, and their expressions of goodwill, when everyone could hear the latter, and also when everyone could see the gift. He had spoken to their worthy Hon. Secretary Mr. S. Y. Shoubridge; and he proposed that they should send a telegram to the German Gas Association. He would read what he thought they ought to send: "The President and members of the Institution of Gas Engineers, assembled in annual meeting in Glasgow, send hearty greetings to their brethren of the German Union of Gas and Water Engineers, and express their very hearty thanks for their kind greetings and handsome and welcome present most opportunely received." He had spoken that day of the German visit; and he was doubly glad that he did so, in view of their kind remembrance of them. When Bailie Paxton, at their meeting in London last year, gave the Institution an invitation from the Corporation of Glasgow to hold the meeting in Glasgow this year, the proposal was received with much pleasure, and without a single voice of dissent. The Lord Provost had referred to the important part the gas industry was bound to take in the matter of smoke abatement, and the direction in which they must work most strongly. In Glasgow, during the past few weeks, there had been a good deal of discussion as to whether the factory or the domestic chimney was the greater sinner in the pollution of the air. He would draw the attention of those interested to the clear atmosphere and the sunny skies which they had been enjoying lately, and would point out that, while the factories went on regularly all the year, a large proportion of the domestic chimneys were on strike at this warm and holiday season. It was, therefore, to the abolition of the smoke from the domestic chimney that they must give most attention. There was no doubt that in this field gas at the present time offered the only effective and economical remedy. They, as gas engineers, had in the past worked more to give their consumers a good article at a low price; leaving the people to find out for themselves if they even required their commodity. While not lessening their efforts to reduce the cost of manufacture, they now felt the necessity of advertising their wares, and showing their customers how much they could do to assist them, and how well they could do it. He could assure the Lord Provost that no effort would be wanting on the part of the members of the Institution to do all they could to assist in solving this most important question of smoke abatement. Their organization had been established for nearly half-a-century, and their industry for more than double that time; but he believed they were all of opinion that, great as had been the success of gas undertakings in the past, they were now entering on an era of much greater usefulness and prosperity.

Mr. R. G. SHADBOLT (Grantham) proposed "The Corporation of Glasgow Gas Committee." He said that a Committee of this character, charged with the administration of an estate of the capital value of not less than two-and-a-third millions sterling—a Committee who had to deal with an annual revenue of over three-quarters of a million pounds—must look with the gravest sense of responsibility upon the task which lay before them when they first took it up, as members of the Committee. The responsibility must weigh upon them very heavily, more particularly from the fact that these gentlemen gave of the best of their services to the community among which they moved and lived and had their being, without fee and without the expectation of reward, laying

themselves open to the keenest of critics, and often bringing down upon their devoted heads the unprovoked wrath of hundreds of their constituents. But while the magnitude might bring an overwhelming sense of responsibility, this magnitude, in itself, was no criterion as to whether or not they were discharging their duty, and doing that which was expected of them. Whether their lot were cast in a large city or in a small town, the great question was, with regard to the administration, how they had discharged their responsibility. What account had they to give of their stewardship? It was this by which they were judged, be the undertaking large or small. In listening to the excellent address of Mr. Wilson that morning, one was struck with the vastness of the field of operations over which the Committee presided. They had undoubtedly one of the finest fields for the distribution of gas that one could find throughout the length and breadth of the land; and with characteristic caution, they had made certain and sure progress in regard to their duties to the community in this respect. But what they had done in the past, compared with what they had the opportunity of doing in the future, was almost out of all proportion. When they considered that, after all that had been done in Glasgow up to the present time, only one gas cooker, or griller, or cooking apparatus of any kind was let out on hire to each four of their consumers, he need not tell an audience of this character what a great future there was before them in this particular direction. When he went further, and pointed out that that most popular instrument known as the slot-meter, though it had evidently taken on in Glasgow, was only in use by 20 per cent. of the consumers, the audience would again realize the vast possibilities which lay before the Committee in regard to the distribution and supply of gas. When he told them, in addition to this, that in their large manufacturing centre the total quantity of gas used last year in engines and for manufacturing purposes only amounted to the proportion of 9 per cent. of the total output, they would again realize what a vast responsibility lay before the Committee. When these figures had reached record proportions, the magnitude of the undertaking would be tremendously greater than it was at the present day. He need not touch upon the historical aspect of the gas-works, because this had been graphically described to them by the President. Suffice it to say the Glasgow Corporation, or the Gas Committee, had had a sufficiently long experience of administering gas affairs to show to the world what municipal management of such undertakings could do. Glasgow had always been notorious among gas men as a place where the gas undertaking was administered for, and on behalf of, the consumers only. The gas consumers of Glasgow consequently were to be congratulated upon the conditions which had existed so long, and which their recent parliamentary effort had further clinched, so that, neither by slip of tongue nor pen, could the interests of the gas consumer be over-ridden by other untoward circumstances. But though this was assured, there was one thing included in this case which would redound to the interest of the gas consumers of Glasgow —and it could not be too widely known—more than any other factor; and this was the further reduction in the illuminating power standard from 16 to 14 candles. When the consumers realized what this meant to them, in regard to the control of the supply they could obtain for the money expenditure, they would thank the Corporation for having given them this concession. They had, in these commercial days, frequently put to them the question as to which was the dominating factor in regard to gas politics—the administrator, the engineer, the manager, the commercial men, or the secretary. He thought the action of the Gas Committee of Glasgow threw a lurid light upon this question. Taking the last ten years by way of indication, they had reduced the cost of the production of gas by no less than 1s. per 1000 cubic feet. But, mark, only 6d. of this had reached the gas consumer. The rising demands of capital, depreciation, distribution, clerical assistance, stationery, and commercial charges had absorbed half of the 1s.; and if manufacturing costs had not been reduced during this period, the consumers would be to-day charged 6d. per 1000 cubic feet more than they were ten years ago. He thought this was an instance of what, at any rate, at present was the predominant factor in the manufacture and supply of gas, and reflected credit upon the Engineer and his staff as to the way in which they had discharged their duties. So the public of Glasgow might rest very well assured that their interests, not only now, but in the future, were exceedingly bright from their own particular point of view. The enthusiastic manner in which the members of the Gas Committee supported the movement which brought about the Smoke Abatement Exhibition was sufficient to make the exhibition a success. In the words of Scotland's poet, Burns, he could say, as he gave the toast: "May fortune favour worth and merit as they deserve."

Bailie PAXTON, the Convener of the Gas Committee, in responding, remarked that twelve months ago, as they had been told, he extended, on behalf of the Lord Provost and the Corporation, an invitation to the Institution to come to Glasgow—this being the year of Mr. Wilson's holding the office of President. He must say, on behalf of the Gas Committee, that they were most delighted at the response which the members had given to his invitation. The Gas Department of the City of Glasgow did not mean Glasgow proper. It meant a good deal more than this. It meant three or four outlying burghs, and, in addition, a large tract of country property. So they would see that, while they were talking of amalgamating more suburban areas, so far as gas supply was concerned they had had this since 1869. The Gas Committee tried to enlist the sympathy, interest, and support of all the employees. First of all, they wanted to, and they did, pay well every man under their care, because they believed that the way to get the best out of a man was to show him that they were appreciating his every effort. Sometimes when the Gas Committee went to their House of Lords, they found that their House of Lords shook their wise heads, and did not refuse, but said they had better take that back. It must be confessed, to give their House of Lords credit, that some of the Committee went the length of saying that, after all, they might not be very far wrong, though he himself very often differed from this. But, after all had been said and done, the constitution of the Gas Committee made it work very well in the public interest. The Corporation consisted of 80 members; and of this number, 26 formed the Gas Committee. The Corporation, in its corporate body, was the Court of Appeal over the Committee. Nothing could be done without going to the Corporation and telling them what they were doing; and if the Corporation gave them their hall-mark, the thing was all right. He wished to say that the people were much indebted to the Institution for the great advances which had been made in lighting, cooking, and heating by gas, as they now knew it. Not many years ago gas was much dearer. Notwithstanding the fact that wages were now higher, and that the cost of coal was 9d. per ton more than it was some years ago, they had reduced the price of gas by 2d. per 1000 cubic feet, which meant a saving of £50,000 a year to the citizens. This must be attributed, in great measure, to the Engineer of the day, and his staff. So far as the pollution of the atmosphere was concerned, they were making every effort to get the public to use gas. They had had efforts made by gentlemen who produced coalite and other materials—he did not know with what success. But, so far as he was aware, there had been no success at all equal to that of the use of gas for purifying the air. The Smoke Abatement Exhibition which they held last year was such an incentive to the people of Scotland—from Ayr to Edinburgh—that there arose an increased demand for gas fires and appliances—a demand greater than had ever been known before. He would like the Gas Committee to travel a little quicker than they were doing. They had their friend Mr. Hislop, of Paisley, with them that day. Some years ago, Mr. Hislop gave the people gas-cookers free; and he was assured that the increased consumption of gas had paid the Corporation of Paisley amply. He thought they in Glasgow might, with considerable benefit to the public, adopt the same principle in Glasgow. It would pay them, and would add to the comfort of the people. He observed in that day's "Glasgow Herald" that in Ardrossan they gave free gas-cookers, with the result that they had an enormous increase in the output of gas. He submitted that the only way in which the air could be purified was by a liberal giving to the people of something more tangible than lectures or exhibitions. This would be a gain to both parties.

Mr. EDWARD ALLEN (Liverpool) proposed the toast of "The Chairman."

The LORD PROVOST acknowledged it in humorous vein.

The proceedings were brought to a close by the singing of "Auld Lang Syne."

A photograph of the guests was subsequently taken in the quadrangle of the City Chambers.

THE BENEVOLENT FUND.

Meeting of Donors and Subscribers.

The Annual Meeting of the Donors and Subscribers to the Benevolent Fund was held on Wednesday morning—the PRESIDENT in the chair. There was only a very limited attendance.

The HON. SECRETARY (Mr. Walter T. Dunn) read the minutes of the last annual meeting; and they were confirmed.

The PRESIDENT said that as every member had received a copy of the annual report of the Committee [see *ante*, p. 585], it would not be necessary to read it. The Committee had had a meeting that morning, and had gone into the cases which had been receiving assistance during the past year; and in every instance, with the exception, he thought, of two, which were adjourned for a little further inquiry, the grants had been continued. He was glad to say that, owing mainly, he believed, to the efforts of the various District Associations, subscriptions were increasing slowly. While they would like them to increase much faster, they were very grateful to know that the fund was receiving more attention. The fund was doing a great deal of good. They did not publish the names of those assisted from it; but any member could, of course, on request, get information with reference to any of the cases he wished to know about.

Mr. J. L. CHAPMAN (Harrow) seconded the motion.

Mr. J. FERGUSON BELL (Derby) said they were very glad to hear from the President that there was an increase in the number of subscribing members; but he found, on totalling them up, that only about 270 subscribed out of the total of 843. He thought there was still a great deal of room for improvement. He was quite sure that if the members of the Institution had the cases before them as the Committee had, there would be a very ready response to the call for subscriptions. It only wanted, he thought, to be brought to the notice of the members that there was urgent need for subscriptions to be forthcoming. Every member might give something, even if small, to this very deserving fund.

The motion was carried.

The PRESIDENT then read the report of the Scrutineers, certifying that Mr. J. Ferguson Bell and Mr. H. C. Head had been duly elected members of the Committee, in place of Mr. Charles Carpenter and Mr. Timothy Duxbury, who retired by rotation.

There being no further business, the meeting was brought to a close.

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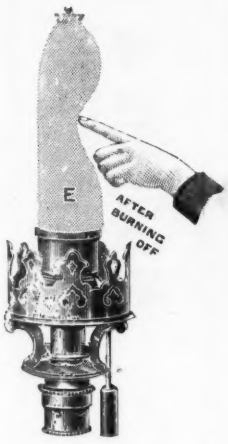

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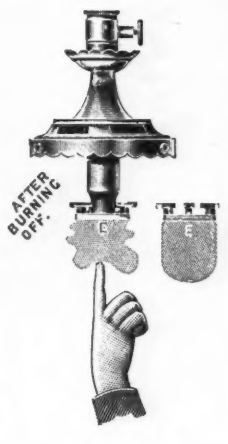

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THE DESSAU VERTICAL RETORTS AT SUNDERLAND.

By CHARLES DRU DRURY, of Sunderland.

The installation of Dessau vertical retorts at the Ayres Quay works of the Sunderland Gas Company consists of one bench of six beds of ten retorts each, set in two rows of fives. Each retort is 4 metres (13 ft. 1½ in.) long; the section at the top being 9 in. by 22½ in., tapering to 13¾ in. by 27¼ in. at the bottom.

The Ayres Quay works are the smaller of the two gas-works owned by the Sunderland Gas Company, and were first erected in 1847. The plant having become worn out, the old works were shut-down early in 1908, and with the exception of the two holders, were entirely reconstructed; subsequently being brought into use again in December, 1909. The Directors took the opportunity thus afforded them of adopting the Dessau vertical retort system for carbonizing purposes; and the sixty retorts on this principle constitute the whole of the gas-producing plant at these works, although there is sufficient space left in the retort-house for a second installation of similar size.

With twelve-hour charges, such as are at present being worked, the installation is capable of carbonizing 58½ tons of coal per twenty-four hours, or 410 tons per week. But allowing for retorts laid-off for scurfing, the carbonizing capacity is reduced to 57 tons per day, or about 400 tons per week, from which, with the aid of gentle steaming, for a period of the charge, a daily make of about 720,000 cubic feet of gas is obtained. The ground space occupied by the bench is 90 ft. by 17 ft. 6 in., or 1575 square feet, which is equal to 2·1 square feet per 1000 cubic feet of gas made.

After thoroughly drying the new bench for six weeks, the brickwork was gradually heated up, and on Dec. 1, 1909, the furnace doors were closed; gas making being commenced on Dec. 4, 1909. Since that date the retorts have worked continuously, and have carbonized up to the present time a little over 30,000 tons of coal.

With the exception of the lower lengths of the retorts and the brickwork in the combustion chambers (all of which is of Stettin material), and a very few special fittings, the whole of the bench was constructed of British material and British workmanship.

The contractors for the bench were the Dessauer Vertikal-Ofen-Gesellschaft m.b.H., of Berlin, with Messrs. Leech, Goodall and Co., Limited, of Leeds, and Messrs. Samuel Cutler and Sons, Limited, of London, as sub-Contractors. The former firm were responsible for the brickwork and retort-setting, and the latter for the steel and ironwork. The amount of the contract for the bench complete, exclusive of the foundations and the coal and coke handling plant, was £10,210.

The retorts are charged and discharged entirely by hand without the aid of any machinery. Two stokers per eight-hour shift do the whole of the work, as well as the filling and clinkering of the producers, the regulation of the steam supply to the retorts, the cleaning of the gas take-off pipes, sweeping up, &c., &c. A labourer attends to the breaking and elevating of the coal, and to the elevating of the coke for the producers and the breeze for the bottoms of the retorts, and labourers scurf the retorts and clean out the hydraulic mains. The wages of the six stokers, who are paid 5s. 9d. per shift, amount to 34s. 5d. per twenty-four hours. This works out at 7·25d. per ton of coal carbonized, or 0·57d. per 1000 cubic feet of gas made on the basis of 58 retorts only at work out of the 60; the other two, as a rule, being laid-off for scurfing.

The coal, after being discharged from railway waggons, is fed through a breaker, whence it is elevated to a rotary screen in the roof of the retort-house, where it is divided into "rough" and "small;" and thus divided it is delivered into a receiving hopper, with a division plate in the centre, providing accommodation for both grades of coal. This hopper is fixed at one end of the bench, and each half of it is provided at the bottom with a door, by means of which the "rough" or "small" coal is drawn off into a small side-tipping truck running on rails laid on the top of the continuous hoppers, which also are provided with a centre plate separating the coal. Thus one side of the hoppers can be filled with the rough and the other with the small coal.

The light sheet-iron travelling charging shoot hangs on rails suspended from the underside of the continuous hoppers, and is made to swivel, so that it can feed either row of retorts at will. By pulling a lever, this shoot is filled from one of the numerous doors on the underside of the hoppers; and as it also is provided with a centre plate, the division of the coal is maintained throughout its handling. After centreing, the door of the shoot is opened, and the retort charged with two parallel streams of rough and small coal—an arrangement which in the case of unscreened coal containing a large amount of small and dust, materially assists the gas generated at the bottom of the retorts in percolating through the charge, and in reducing any tendency to excessive back-pressure at this point. With 4-metre retorts, the separation of the coal would in many instances be unnecessary; but in the case of the Sunderland installation, where unscreened Durham coal has to be dealt with, it was considered desirable to make arrangements for such grading.

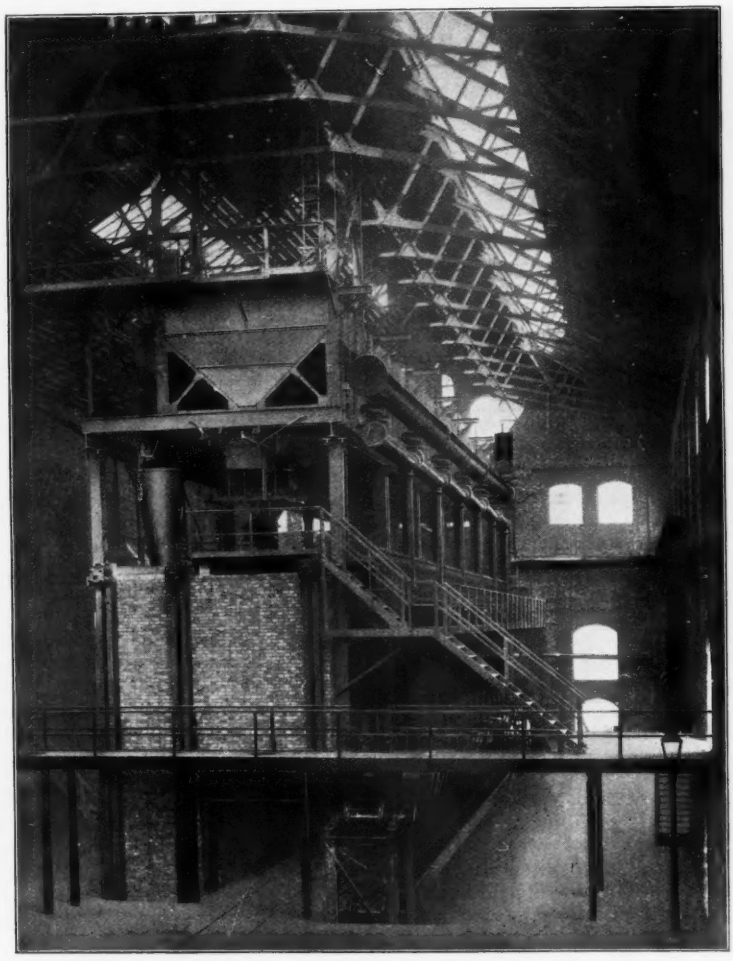


Fig. 1.—End View of the Dessau Vertical Retort-Bench at Sunderland.

Although provision was made for measuring a fixed charge of coal into each retort, it was soon found that this system was not altogether satisfactory, since the capacity of each retort varies with the growth of carbon on its interior; and therefore a charge which just filled a clean retort overfilled one about ready for scurfing. The method was therefore adopted of giving the stoker a rod with a flat disc fixed on its end to hold in a defined position in the interior of the retort, and which enabled him, when charging to feel when the retort was full, and shut off the supply of coal.

Fig. 2.—The Charging Floor at Sunderland.

Before charging with coal, a small quantity of breeze (about 1 cwt.) is introduced into each retort by means of a special travelling breeze-shoot hanging from the same overhead rails as the coal-shoot, in order to fill up the space immediately above the discharging door and to bring the coal itself within the carbonizing zone of heat. On discharging the retort, this breeze is automatically screened out of the coke as it passes up the inclined portion of the hot-coke conveyor, and is used over and over again.

The retorts are discharged and charged every two hours, ten at a time—*i.e.*, 5 retorts from each of two beds; the operation occupying from 15 to 20 minutes. To discharge a retort, the stoker standing on the ground, after first starting the hot-coke conveyor, opens the lower retort door by means of the hand-operated gear, and the coke drops, *via* a wide travelling shoot, running on rails laid in an open tunnel underneath the retorts, into the conveyor constructed in front of the bench, where it is automatically quenched and carried outside to the coke yard. This travelling shoot not only directs the coke on to the conveyor, but gently regulates the flow in such a manner that the conveyor is never overloaded.

The period of carbonization of the charge may be varied to suit differing conditions; but a twelve-hour charge, including two hours of gentle steaming, has been adopted in Sunderland as best suited to requirements. With this method of working, no difficulty is found in producing gas of 15½-candle power (No. 2 "Metropolitan" burner).

The arrangements for steaming are as follows: Steam from the works' boilers is supplied to a pipe running along the front of the bench, from which a small supply pipe is carried to the bottom of every retort. These individual supplies are each fitted with a steam-valve, on the outlet of which is inserted a disc, having a small hole 3/16 inch diameter drilled in it, which limits the amount of steam passing when the valve is full open—for the valves are always left either full open or quite shut. Further and more complete regulation is provided by means of a steam-reducing valve fixed at the inlet end of the main supply, and which reduces the pressure from the 80 lbs. boiler pressure to a range of from 0 lb. to 10 lbs. per square inch; the usual pressure worked being 4 lbs. to 6 lbs. By varying this reduced pressure, the quantity of steam entering the retort is increased or diminished, and thus the quality of the gas made can be readily regulated, and the production of water gas adapted to the particular variety of coal which may happen to be in process of carbonization at the time. A very flexible method of adjusting the quantity and quality of the gas produced is therefore provided by this system of steaming.

To enable the retorts to discharge their contents as far as possible without assistance, the removal of carbon has to be regularly and systematically carried out. For this purpose, two retorts per day are successively laid off for twenty-four hours for cleaning on five or six days in each week. The effect of this arrangement is that every retort is scurfed on the average once in five-and-a-half weeks.

The coke for the producers is raised in small trucks by means of an electric hoist to an overhead bunker placed alongside the continuous coal-hoppers, whence it is drawn off from time to time into a light travelling charging shoot, suspended from a monorail, and dropped into the producers, the feeding doors of which are fixed at the same level as the retort charging floor. The producers are filled once per eight-hour shift, and clinkered once every 48 hours; being twice pricked-up between the periods of clinkering.

The draught on the furnaces is very carefully watched, and is regulated every two hours by means of the dampers upon each setting, so as to maintain a vacuum of 8 mm. (3-10ths inch) at the lowest conveniently observable waste-gas flue in the regenerator. At the same time, the primary air slides are adjusted so that only a very slight blue tinge can be observed in the waste gases at the same point. The secondary air slides are only altered when some radical change in the heating of the settings is required.

A feature of these producers is the rectangular boiler fixed under the ash-pan, and under which the waste gases finally pass. A constant trickle of water passes into the boiler, which is kept about half full. This water is slowly vaporized, and passes in with the primary air to the underside of the fire-bars.

The draughts on the main flue and regenerator run as follows:—

	Inch.	
Draught at base of chimney	12-10ths	water gauge.
,, in main flue (reduced by main damper) .	7-10ths	do.
Waste-gas flues (reduced by setting dampers)	8 m.m. = 3-10ths	do.
,, ,, (highest sight hole)	4 m.m. = 15-100ths	do.
Secondary air flues (do. do.)	3 m.m. = 11-100ths	do.

The system of heating the vertical setting is a graduated one; the retorts being kept hotter at the bottom than at the top. The setting is divided vertically into four horizontal chambers; the heating gases passing zig-zag fashion from the bottom to the top, and thence downwards through the regenerator. The regulation of the heats is principally effected by adjusting the secondary-air slides, and also the internal nozzle bricks and the dampers inside the setting.

Numerous observations of the temperatures inside the setting have been made by means of a Féry pyrometer; and the following results are typical:—

Combustion Chamber.	Second Chamber.	Third Chamber.	Fourth Chamber.
2370° Fahr. ..	1990° Fahr. ..	1760° Fahr. ..	No observations taken.
2390° Fahr. ..	1950° Fahr. ..	1780° Fahr. ..	Do.

The deep furnace constitutes a hopper for the coke; and consequently a producer gas of very regular composition and quality is obtained, since the generator is always kept full.

Average results of many tests of the composition of the producer and waste gases obtained give the following results:—

	CO_2.	O_2.	CO.
Producer gas . . .	5·5 per cent.	.. 0·3 per cent.	.. 24·5 per cent.
Waste ,, . . .	17·2 ,,	.. 1·4 ,,	.. 0·4 ,,

To prevent overheating, two Seger cones, Nos. 16 and 18 respectively, are placed in each of the six combustion chambers in the setting, and are observed twice per shift. No. 16 cone has a melting point of 2660° Fahr., and No. 18 a melting point of 2732° F. To prevent any failure in the action of these cones, they are renewed every two or three weeks. The result of many continuous observations of the temperature of the waste gas in the main flue as it leaves the bench shows it to range from 485° to 535° Fahr., with an average temperature of 507° Fahr.

The gas take-off pipes, of which there is one to each retort, give no trouble. As a precaution, however, the stokers push a rod with a disc at the end of it through each pipe—once a week for the shorter and twice a week for the longer pipes—to clear out any thick stuff which may be collecting in them. The time selected for this operation is about the third hour of the charge, when any deposited tar is in a buttery condition. Stopped pipes, as understood in connection with horizontal retorts, are unknown.

The upper portion of each hydraulic main is divided longitudinally by an internal plate or curtain dipping into the liquor, and doors are provided on the outer portion of the main enabling the pitch pans, which are laid on the bottom of the main under each of the dip-pipes, to be withdrawn periodically, and the pitch deposited in them removed—thus keeping the mains in good order. At Sunderland, this is done once per week; and about 15 cwt. of such pitchy material is in this manner removed from the six hydraulic mains in the period named. The tar itself is taken off from the bottom of the main; and the liquor level is regulated by means of a weir valve.

The practice has been adopted at Sunderland of working the retorts without a seal, except when the lids are open for charging or discharging, during which time the dips are temporarily sealed with weak liquor to the extent of about an inch. The 3-inch vacuum produced by the exhauster is reduced by means of a Cowan retort-house governor, and maintained at level gauge on the hydraulic mains.

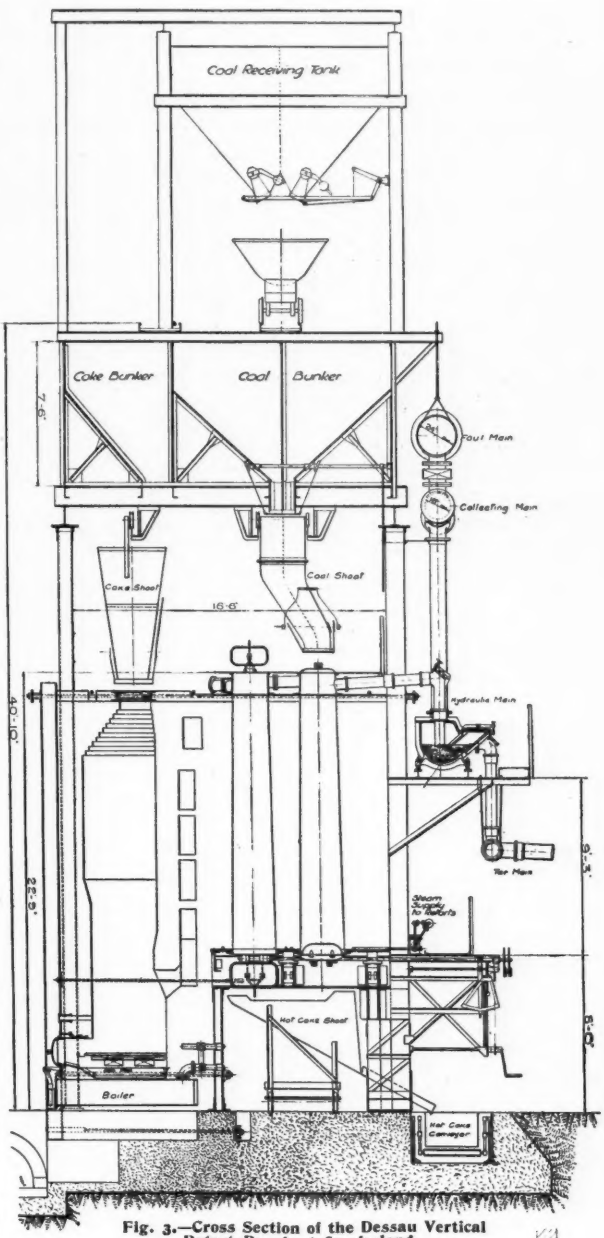


Fig. 3.—Cross Section of the Dessau Vertical Retort-Bench at Sunderland.

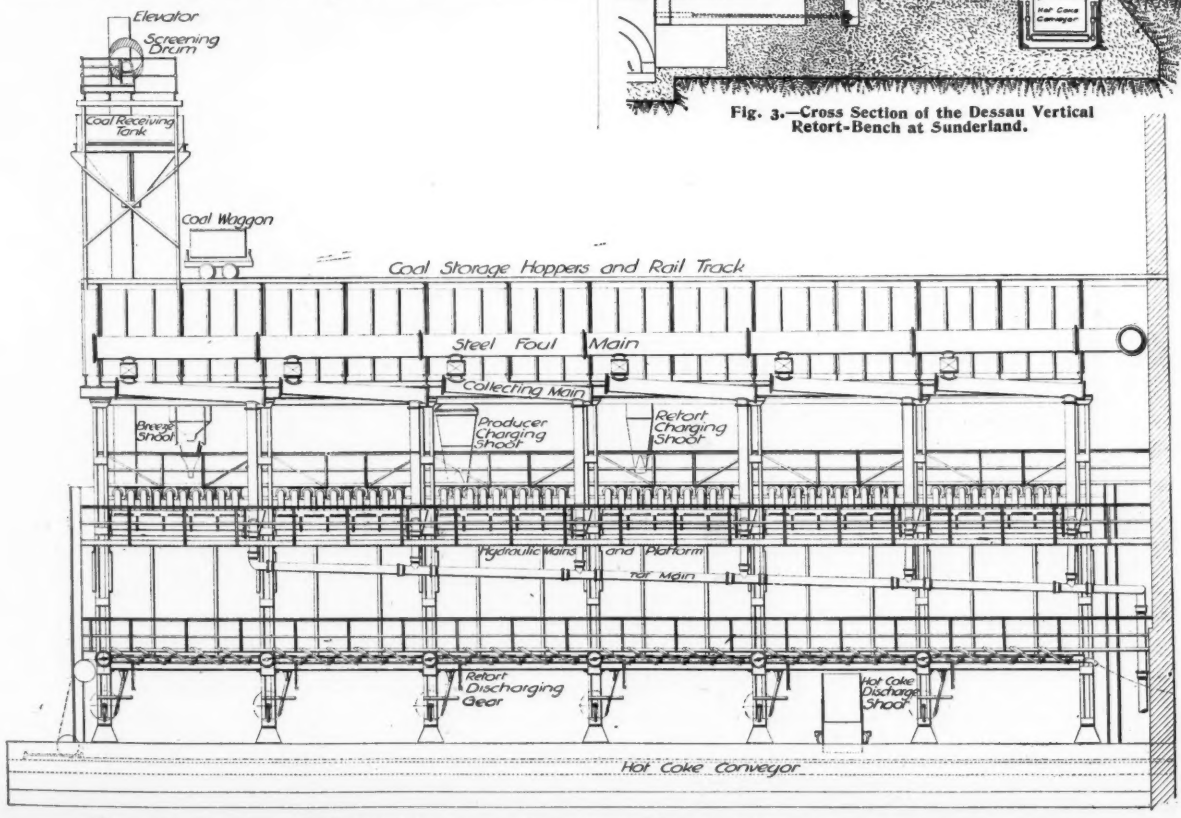


Fig. 4.—Cross Section of the Retort-House for Sixty Dessau Vertical Retorts at the Ayres Quay (Sunderland) Gas-Works.

Careful tests have been repeatedly made to ascertain the pressures of gas inside the retorts; and representative results are given in the following table:—

Pressures at Bottom of Retorts.

—	Pressures in Tenths of Inches.					
First charged (dips sealed)	45	25	39	49	65	43
,, ,, (dips unsealed)	35	20	28	45	63	38
End of first hour	30	12	6	30	42	32
,, second ,,	10	5	5	7	28	8
,, third ,,	3	2	4	2	20	3
,, fourth ,,	2	1	2	1	12	1
,, fifth ,,	1	0	1	1	5	1
,, sixth ,,	2	0	1	0	2	0
,, seventh ,,	(Not observed)			0	1½	(not observed.)
,, eighth ,,	,,			0	1	,,
,, ninth ,,	,,			0	1	,,
,, tenth ,,	,,			0	1	,,
,, eleventh ,, steaming.	,,			(Not observed)		,,
,, twelfth ,, ,,	,,			,,	,,	,,

The corresponding pressures at the top of the retorts varied from level gauge to one-tenth of an inch. A typical curve showing the pressures at the bottom of a retort is appended.

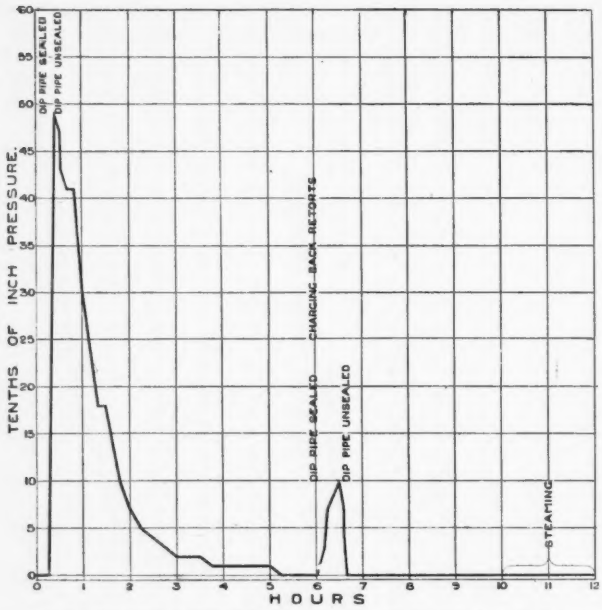


Fig. 5.—Pressure of Gas at the Bottom of a Vertical Retort during a Twelve-Hour Charge.

This curve incidentally shows the detrimental effect of having to seal all the ten dip-pipes in the main when only five are opened out.

One of the conditions of the contract for the erection of the installation was that all guarantees should be proved in a trial of 48 hours' duration within three months after the bench had been started to work, the bench to be in full action with all the retorts free from carbon. The results of this test, made between Jan. 6 and 8, 1910, are set out below:—

Results of Test.

Duration of test	48 hours.
Duration of charge (no steaming)	11 ,,
Coal carbonized	124·11 tons.
Gas made (corrected to 30 inches bar. and 60° Fahr.)	1,492,900 cubic feet.
Gas made per retort	12,441 cubic feet.
Gas made per ton of coal carbonized	12,028 ,, ,,
Illuminating power (No. 2 "Metropolitan" burner)	17·55 candles.
Calorific power (gross)	635·4 B.Th.U.
,, ,, (net)	568·0 ,,
Coke used for fuel (dry)	17·3 tons.
Coke used per ton of coal carbonized	13·96 per cent.

The coal used on this occasion was a second-class Durham. The gas was purified by oxide only; and no air was admitted for revivification purposes.

In consequence of the difficulty under the system of eleven-hour charges of dividing up the work among the three eight-hour shifts, it was decided, shortly after the guarantee test, to adopt twelve-hour charges, including a period of two hours' gentle steaming; and this arrangement has been adhered to practically ever since.

The working of the installation for the first three months after starting was naturally somewhat of an experimental nature, especially as the whole of the plant in the works was also quite new. The author, therefore, decided to exclude this period, and to include the figures for the first three months of this year in the working results for twelve months which follow:—

Working Results Obtained from Vertical Retorts at Ayres Quay Works for twelve months ending March 31, 1911, together with a Comparison of the Results Obtained from Horizontal Retorts at the Company's Hendon Works for the Same Period, and Using Practically the Same Coal:—

—	Ayres Quay Verticals.	Hendon Horizontals.
Coal carbonized, tons	20,349	71,069
Retorts charged	21,340	
Weight of coal per charge, cwts.	9·54	
Gas made (corrected to 30 inches bar. and 60° Fahr.) thousands of cubic feet	257,365	
Gas made per ton coal, cubic feet	12,647	10,638
,, per retort, cubic feet	12,060	
Illuminating power (No. 2 "Metropolitan" burner), candles	15·52	18·22
Sperm value per ton coal, lbs.	672	664
Calorific power per cubic feet (gross), B.Th.U.	590	611
,, ,, (net) ,,	531	545
Specific gravity	0·417	0·408
Sulphur in purified gas per 100 cubic feet, grains	20·2	9·53
Ammonia ,, ,, ,, ,,	0·26	0·70
Naphthalene ,, ,, ,, ,,	2·54	2·84
Air for revivification, per cent.	2·91	
Coke and breeze for sale per ton coal, cwts.	11·25	11·49
Tar made per ton coal, gallons	11·40	10·34
Liquor (as sulphate) per ton coal, lbs.	28·66	24·07

At the Hendon works, the retorts in one house are charged and discharged by West's compressed air stoking machinery, and by De Brouwer stoking machinery in the other. Owing to circumstances, it has so far not been found convenient to fill up the retorts; and the average charge for 19-feet retorts is 6 cwt. per six hours. Lime only is used for purification and the gas is washed with a solvent oil for the reduction of naphthalene. From the gas produced at the Ayres Quay works, no deposits of naphthalene have, even under the severest climatic conditions, ever been traced; whereas serious trouble in this direction has, previous to washing with a solvent, been experienced with the gas from the Hendon works.

It will be seen from this comparison that there is an increase with verticals of 2009 cubic feet of gas, 1·06 gallons of tar, and 4·59 lbs. of sulphate of ammonia per ton of coal carbonized. It will also be observed that, although there is a reduction in the candle power of nearly 2¾ candles, the reduction in the calorific power is only trifling. The total sulphur, exclusive of sulphuretted hydrogen, in the unpurified gas at the Hendon works averages about 35 grains; and the naphthalene content of this gas for several months before washing with a solvent averaged 6·4 grains per 100 cubic feet.

The coal carbonized in verticals during the twelve months under consideration was a fairly equal mixture of two second and two third class unscreened Durhams, having the following approximate analyses:—

Water.	Volatile Hydrocarbons.	Fixed Carbon.	Ash.	Sulphur. (Separate Estimation)
Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
1·69	29·54	60·20	8·57	1·69
1·56	28·87	61·67	7·90	1·58
1·81	29·19	58·18	10·83	1·34
2·28	28·69	57·98	11·05	1·79

The coal as a rule ran very fine; and average results of screening occasional truck-loads showed that the amount which passed through a ¼-inch mesh screen varied from 28 to 47 per cent., according to the class of coal tested.

Oxide of iron only is employed at Ayres Quay for purification purposes; and the air used for revivification is drawn in at the inlet of the exhauster after passing through a rotary meter.

The following table shows the comparative figures for the vertical retorts for the four quarters included in the twelve months' survey; the variations in the results being chiefly

due to the changes in the proportions of the different coals carbonized:

Comparative Figures for Vertical Retorts.

—	June, 1910.	Sept., 1910.	Dec. 1910.	March, 1911.
Gas made per ton (corrected for temperature and pressure) cubic feet	12,474	12,493	13,025	12,616
Illuminating power (No. 2 "Metropolitan" burner) candles	15·7	15·6	15·5	15·3
Sperm value per ton coal, lbs.	671	668	692	661
Calorific power per cubic foot (net) B.Th.U.	543	535	524	520
Specific gravity	·420	·419	·414	·415
Sulphur in purified gas per 100 cubic feet, grains	20·6	21·1	18·7	20·4
Ammonia ,, ,, ,, ,,	0·	0·29	0 23	0·18
Naphthalene ,, ,, ,, ,,	1·46	3·86	3·06	1·80
Percentage of air admitted for revivification	2·27	3·07	3·21	3 09

From an early stage in the working of the verticals, it was found advantageous to admit a limited amount of steam into the retorts. Without steam the most suitable duration of charge for the class of Durham coal used appears to be eleven hours, as compared with twelve hours when steaming; but as the former period was found to be inconvenient in many ways, no lengthy trials have been made without steam. Such as have been carried out, however, reveal the fact that the make and quality of the gas varied as follows:

Variation of the Make and Quality of Gas.

—	Gas Made per Ton (Corrected).	Illuminating Power.	Calorific Power (Net).
	Cubic Feet.	Candles.	B.Th.U.
Unsteamed	11,838	16 86	536
Steamed	12,996	16·62	534
Increase due to steaming	1,158		
Unsteamed	11,314	17·24	553
Steamed	12,270	16·64	556
Increase due to steaming	956		

These results show an average increase in the make of gas of 1057 cubic feet per ton of coal in favour of steaming. Owing to the facts that a change in the coal used occurred on the average twice a week, and that it was very rarely possible to work on the same coal for a longer period than a week, the duration of these last-named tests was usually confined to a couple of days each; and therefore the results, so far as the quality of the gas produced is concerned, must be received with a certain amount of reservation, since it was difficult to regulate the heats from steaming to non-steaming conditions, and *vice versâ*, in so short a time. It, however, appears to be fairly evident that there is an increase of about 1000 cubic feet to the ton when steaming; and this is borne out by the results obtained when testing Derbyshire coal, the full figures of which follow.

In the early portion of this year (1911), a trial of 200 tons of screened Derbyshire coal (Heathcote seam from Grassmoor Colliery) was made in the vertical retorts at Ayres Quay on behalf of the Derby Gaslight and Coke Company; and the author has the permission of their Engineer and Manager, Mr. J. Ferguson Bell, to publish the following figures:—

Analysis of Grassmoor Coal.

Carbon	72·91	Ash	5·95
Hydrogen	4·95	Moisture (at 110° C.)	6 33
Oxogen (by difference)	6·05	Volatile matter (dry coal)	35·91
Nitrogen	1·48	Specific gravity (water 1·000)	1·277
Sulphur (total)	2·76		

Results of Tests.

—	Unsteamed.	Steamed.
Coal carbonized, tons	162·1	45
Gas made (corrected for barometer and temperature), cubic feet	2,023,000	602,160
Gas made, per ton coal carbonized, cubic feet	12,480	13,381
Illuminating power (No. 2 "Metropolitan" burner), candles	15·63	15·47
Sperm value per ton coal, lbs.	686	709
Specific gravity of gas (air = 1·000)	·454	·457
Calorific value per cubic foot (gross), calories	149·4	147·8
,, ,, (net) ,,	133·7	132·2
Sulphur (CS_2) (oxide only), (Harcourt's), grains.	34·40	35·60
,, (total) ,, (Referees'), ,,	39·89	38·89
Naphthalene per 100 cubic feet ,,	2·23	2·71
Solvents ,, grammes	70·50	77 0
Carbon dioxide in crude gas, per cent. volume	2·4	2·5
Sulphuretted hydrogen in crude gas per 100 cubic feet, grains	796	816
Cyanogen as prussiate in crude gas per ton coal, lbs.	3·96	3·65
Ammonia (washer outlet) per 100 cubic feet, grains	0·67	0·74

Average Analysis of Purified Gas; Oxide only being Used, and 3 per Cent. of Air Admitted.

—	Without Steam. Volume. Per Cent.	With Steam. Volume. Per Cent.
Carbon dioxide	2·4	2·2
Illuminants	3·9	3·4
Oxygen	0·3	0·4
Carbon monoxide	8·0	7·8
Methane	31·2	29·8
Hydrogen	49·3	51·6
Nitrogen (by difference)	4·9	4·8
	100·0	100·0
Nitrogen (by combustion)	4·8	4·2

Reverting to the results obtained from Durham coals, the amount of coke used for fuel (dry) worked out, as an average of several weeks' trial, to 17·8 per cent. of the coal carbonized, or 34 lbs. per 1000 cubic feet of gas made. This high result is, it must be remembered, partly due to the two hours' steaming, with its resultant make of water gas, but the author understands that the fuel account is very materially reduced in the later Dessau settings containing three rows of retorts.

The vertical bench is in one respect at a disadvantage when compared with a horizontal one of the same productive capacity, since the radiating surface of the former is fully 30 per cent. greater than that of the latter; and, moreover, the thickness of brickwork on top of the verticals is considerably less than that of most horizontal benches.

In the opinion of the author, there is little doubt that Dr. Bueb and others are correct in the theory they have advanced that the evolution of the gas from the coal in the retort is principally from the outside inwards, and that the gas ascends through the comparatively cool core of the charge. On opening a retort lid after carbonization is complete, a long deep fissure can often be seen in the centre of the coke, with sometimes a flickering flame of gas slowly curling up therefrom. This fissure may be 12 inches or 14 inches long by 1½ inches to 2 inches wide in the centre; and on several occasions it has been probed with a rod for the purpose of ascertaining how far it extends into the coke. It has repeatedly been found that the rod can be lowered into the fissure as far down as, and in some cases beyond, the centre joint of the retort, without meeting any appreciable resistance. In one instance, the fissure was found to be 5 feet deep, and probably extended deeper still; but irregularities in its direction no doubt prevented the further penetration of the rod.

From careful observations, it would appear that the coal when filled into the retort slightly expands, keeping the coke, which quickly forms on the outer surface of the charge, pressed up against the walls of the retort—the gas generated meanwhile finding its way up the core of the charge. As the heat penetrates the charge, the wall of coke becomes thicker and thicker; and the swelling stage having passed, the centre portion contracts, owing to the loss of its volatile constituents, and the fissure described is formed. Shortly before carbonization is complete, a further shrinkage of the coke from the sides of the retort apparently takes place, and the charge, which had in the first instance, been filled to within 2 ft. 6 in. of the top of the mouthpiece, is, on the average, found to have dropped about 4 inches.

A number of tests to ascertain the temperature of the gas leaving the retorts were made at short intervals throughout the duration of the charges; and the following comparative table shows the average results obtained from both verticals and horizontals:—

Average Tests of the Temperature of Gas Leaving Verticals and Horizontals.

—	Verticals.	Horizontals.		
		Front Side	Back Side	Average.
	Degrees Fahr.	Degrees Fahr.	Degrees Fahr.	Degrees Fahr.
Temperature of gas at retort lid	815	970	908	939
,, at bridge pipe	222	235	155	195
,, at outlet of hydraulic main	140	137	123	130

The following table showing the averages of observations

of the temperature of the gas taken in vertical retorts every ten minutes throughout the charge may also be of interest:—

Average Temperature of the Gas in Vertical Retorts Taken Every Ten Minutes Throughout the Charge.

Hour.	Front Retort.			Back Retort.		
	Retort Lid.	Bridge Pipe.	Hydraulic Main.	Retort Lid.	Bridge Pipe.	Hydraulic Main.
	Degrees Fahr.	Degrees Fahr.	Degrees Fahr.	Degrees Fahr.	Degrees Fahr.	Degrees Fahr.
1st	568	238	157	675	161	125
2nd	727	252	158	800	181	143
3rd	750	262	149	796	188	135
4th	766	274	136	776	185	120
5th	753	264	135	772	181	122
6th	775	268	128	778	177	125
7th	752	266	133	834	174	134
8th	780	254	150	844	169	157
9th	776	243	143	833	171	145
10th	767	235	132	833	171	123
11th steaming	780	245	135	858	177	121
12th steaming	744	229	129	854	183	121
Average	748	253	140	804	176	131

The difference between the temperatures of the gas at the bridge pipes of the front and back retorts is accounted for by the fact that the gas take-off pipe of the former retort is much shorter than that of the latter.

Reproductions of representative charts from the Beasley recording calorimeter are appended. They were not obtained on the same day, as only one instrument was available, but are reproduced as being sufficiently comparative to be interesting.

Fig. 6 shows the net calorific power of the gas made from verticals at the inlet of the holder over twenty-four hours.

Average computed value of record . . . . . 544 B.Th.U. net
Average computed value of record (corrected for temperature and pressure) . . . . . 531 ,, ,,
Average of simultaneous readings on Simmance-Abady's calorimeter . . . . . 532 ,, ,,

Fig. 7 shows the net calorific power of the gas delivered from the holder over twenty-four hours.

Average computed value of record . . . . . 532 B.Th.U. net
Average computed value of record (corrected for temperature and pressure) . . . . . 520 ,, ,,
Average of simultaneous readings on Simmance-Abady's calorimeter . . . . . 518 ,, ,,

This chart was taken when working in and out of one holder in which the inlet and outlet pipes are placed side by side, and is significant as showing what an efficient mixture of the gas is obtained even under these conditions.

The following figures show the results of several estimations for impurities in the crude steamed gas:—

Sulphuretted hydrogen . . . . 595 grains per 100 cubic feet
Ammonia . . . . . 210 ,, ,, ,, ,, ,,
Cyanogen as prussiate . . . . 2·04 lbs. per ton coal carbonized

The following table shows the results of several analyses of purified steamed gas taken over a period of six months:—

Analyses of Purified Steamed Gas over a Period of Six Months.

—	Vol.	Vol.	Vol.	Vol.	Vol.	Vol.	Average Vol.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent	Per Cent.	Per Cent.
Carbonic acid	1·40	1·83	1·80	1·1C	1·0C	0·93	1·35
Heavy hydrocarbons	2·80	4·23	4·33	3·9C	3·3C	3·13	3·63
Oxygen	0·70	0·30	0·40	0·2C	0·5C	0·30	0·40
Carbon monoxide	8·35	6·84	6·57	8·2C	7·9C	7·9C	7·63
Methane	31·00	30·8C	31·17	30·1C	29·62	30·07	30·46
Hydrogen	49·00	48·57	50·70	50·35	50·56	50·17	49·90
Nitrogen (by difference)	6·75	7·43	5·03	6·15	6·9C	7·5C	6·63
	100·00	100·00	100·00	100·0C	100·0C	100·00	100·00
Nitrogen (by combustion)	6·80	..	..	..	..	7·00	..

Of the residuals produced by the verticals, the coke is distinctly denser and heavier than that from horizontals; the former, bulk for bulk, weighing about 25 per cent. more than the latter, and approaching much more nearly the quality of good oven coke.

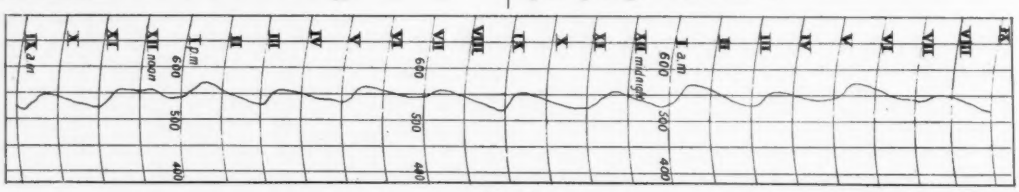


Fig. 6.

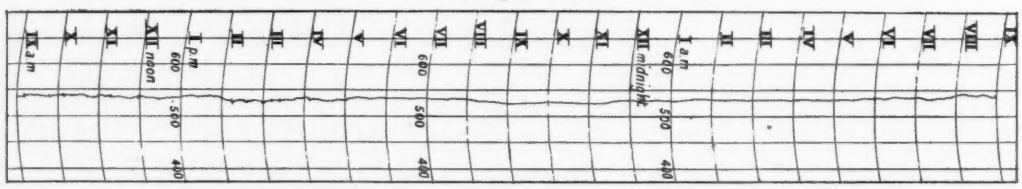


Fig. 7.

Samples of coke from precisely the same coal were analyzed with the following results:—

—	Vertical.	Horizontal.
Carbon	87·22 per cent.	87·04 per cent.
Sulphur	1·55 ,,	1·54 ,,
Ash	10·55 ,,	10·40 ,,
Moisture	0·68 ,,	1·02 ,,
	100·00 ,,	100·00 ,,
Calorific power:—		
Calories	7,030	7,030
British thermal units	12,660	12,660
Pounds of water evaporated from 100° C. by 1 lb. of the coke	13·1	13·1

It will thus be seen that though practically the same in composition yet the cokes differ very greatly physically. The coke from verticals is distinctly larger than that from horizontals; and there is considerably less breeze when carbonizing the same coal.

—	Vertical.	Horizontal.
	Per Cent.	Per Cent.
Large coke (over 2-inch screen)	78·5	69·2
Small ,, (,, 1-inch ,,)	11·3	20·0
Smithy ,, (,, ½-inch ,,)	7·8	4·4
Breeze (through ½-inch ,,)	2·4	6·4
	100·0	100·0

There is little difference found between the moisture in vertical and horizontal coke as taken from the heaps in the yard. The average of many systematic tests of such samples shows:—

Vertical coke . . . . . 4·6 per cent. moisture.
Horizontal coke . . . . . 3·9 ,, ,, ,,

The tar produced from verticals is light and thin. The water content is low (about 1½ per cent.), and the amount of free carbon very much less than in tar from horizontals. The naphthalene is low; and there is a tendency to form paraffin, rather than aromatic bodies with a large proportion of naphthalene.

The following is a comparative analysis of two tars, for which the author is indebted to Mr. E. F. Hooper, a member of the firm of Messrs. Brotherton and Co., of the Wear Tar-Works, Sunderland.

Comparative Analysis of Tars.

—	Vertical.	Horizontal.
Specific gravity	1·113	1·220
Free carbon	4·0	17·25
Tar acids	5·3	3·0
Distillate through open retort to—		
170° C.	13·0	4·9
270° C.	24·0	18·4
350° C.	9·0	9·0
Pitch	50·0	60·6

The pitch obtained from the pitch pans in the hydraulic

mains contains 25 per cent. of free carbon; and, besides a certain quantity of ammoniacal liquor very difficult to separate, there is a large amount of pitchy material exceedingly difficult to distil, and which if left in the tar would spoil its quality. It does not dissolve properly in tar, and if put in the tar well would only accumulate and form an obstruction. It was therefore decided to return the pitch into the retorts; and it is periodically carried up to the charging floor in lumps and thrown into them, with discretion, immediately after charging. No bad results are observed from this practice; and it has proved to be an efficient and economical method of disposing of the material.

It has not been found practicable to measure the amount of virgin liquor produced; and owing to the fact that the seals in the hydraulic mains are after every charge made up with liquor, the strength of which varies from time to time, it would only be misleading to give the percentages of ammonia found therein.

The crude gas, after condensation, is passed first through a Livesey tar-washer and then through a Kirkham, Hulett, and Chandler rotary washer-scrubber. The effluent liquor, after mixing with the virgin liquor in a large well, is pumped into railway tank-waggons and sent to the Company's Hendon works, and converted into sulphate of ammonia.

Although the carbon is removed from each retort every five or six weeks, this is not done so much on account of its excessive growth as that the carbon often accumulates in such a manner that if not removed frequently it interferes with the discharging of the coke. As a matter of fact, considerably less carbon is recovered per ton of coal from verticals than from horizontals, as the following table will show:—

—	Verticals.	Horizontals.	
	1910-11.	1909.	1910.
Coals carbonized . .	20,349 tons	92,346 tons	71,113 tons
Carbon recovered. .	12 t. 12 c. 3 q.	130 t. 11 c. 0 q.	109 t. 16 c. 1 q.
,, per ton coal .	1·40 lbs.	3·16 lbs.	3·45 lbs.

Allowance must, however, be made for the fact that more carbon is removed by burning in the case of verticals than in the case of horizontals. The method of removing the carbon is as follows: The bottom door of the retort is slung on a hook and left about an inch open; the top door being opened full, and a flat steel plate placed over the mouthpiece. This plate is suitably notched to regulate the draughts for burning and loosening the carbon. After about twelve hours, the carbon remaining on the sides is gently tapped and falls to the bottom in large pieces. Beyond this, as a rule no scurfing tools are introduced into the retorts.

After nearly eighteen months' experience with Dessau vertical retorts, the author is convinced that, whatever may be the demerits of an intermittent system, it has many compensating advantages, especially when dealing with a bituminous and caking, and sometimes abnormally swelling coal, such as is raised in the county of Durham. An important point in its favour is that the system is a positive one. If therefore the charge sticks, as charges occasionally do in the upper half of the retort, it is a comparatively small matter for the stoker to release the coke, and then the retort cannot fail to take its full charge of coal at once. The appearance, too, of the coke in its incandescent state may be seen at every discharge, and the condition of the heats and the interiors of the retorts can be observed every time the retorts are emptied. Again, the removal of carbon and the filling of cracks or repairs to retorts can be more readily performed where a retort is unrestrictedly opened. There is no continuously running machinery, or machinery at all in connection with the discharging and charging of the retorts, except the coal and coke handling plant; and this simplification is a no small consideration when dealing with structures, such as retort-settings, which are subject to expansion and contraction in directions difficult to control or foresee.

Of the life of the installation, and the effect on it of wear and tear, it is too early to form an opinion; but so far no repairs, except trifling ones, have been required. There are several directions in which the author considers the installation might with advantage be modified to suit English conditions; but these are only details, and do not affect the principle of the system. In the latest form of setting, containing three parallel rows of retorts, and of which mention has already been made, several such improvements have, it is understood, been effected.

It only remains to say that the installation, with its auxiliary plant for handling coal and hot and cold coke, has worked most satisfactorily and without a hitch from the time it was first started, eighteen months ago.

The system has proved itself capable, if desired, of producing gas of a comparatively high illuminating power, and also affords facilities for stretching the make of gas to varying degrees of lesser illuminating power by means of its steaming arrangement, showing it to be a plant of very flexible character.

THE WOODALL-DUCKHAM SYSTEM OF VERTICAL RETORTS.

By J. P. LEATHER, of Burnley.

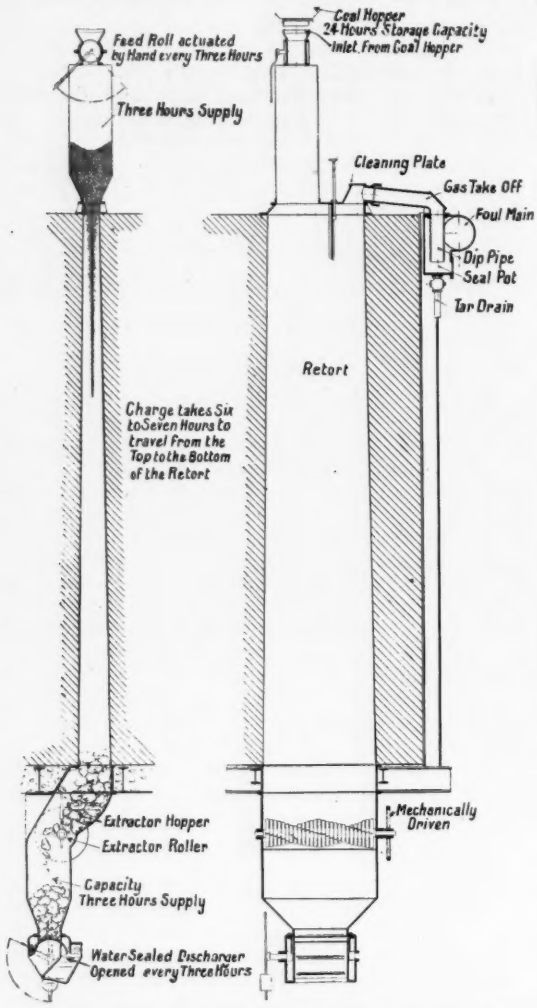
It is the duty of any member of our Institution who makes any important departure from accustomed methods of gas manufacture to acquaint his fellow-members with his experience. Progress in new methods is often like our early lessons in walking—a series of attempts and failures. Nevertheless, our failures are fewer, and the perfection of our success greater, when we have the experience of others to guide us. The writer, therefore, on being invited by the President to contribute his quota to the information respecting vertical retorts to be given at the Glasgow meeting, felt that, however imperfectly, he must communicate something of that which he had learned as to continuous carbonization.

The gas from the vertical retorts at Burnley mixes with that from other parts of the works before passing to the exhausters, and before purification. The writer, however, hoped, when he undertook to prepare the present paper, to be able to supply fuller figures as to quantity and quality of gas made per ton than he now finds possible, but trusts that such information as he is able to give may not be without interest.

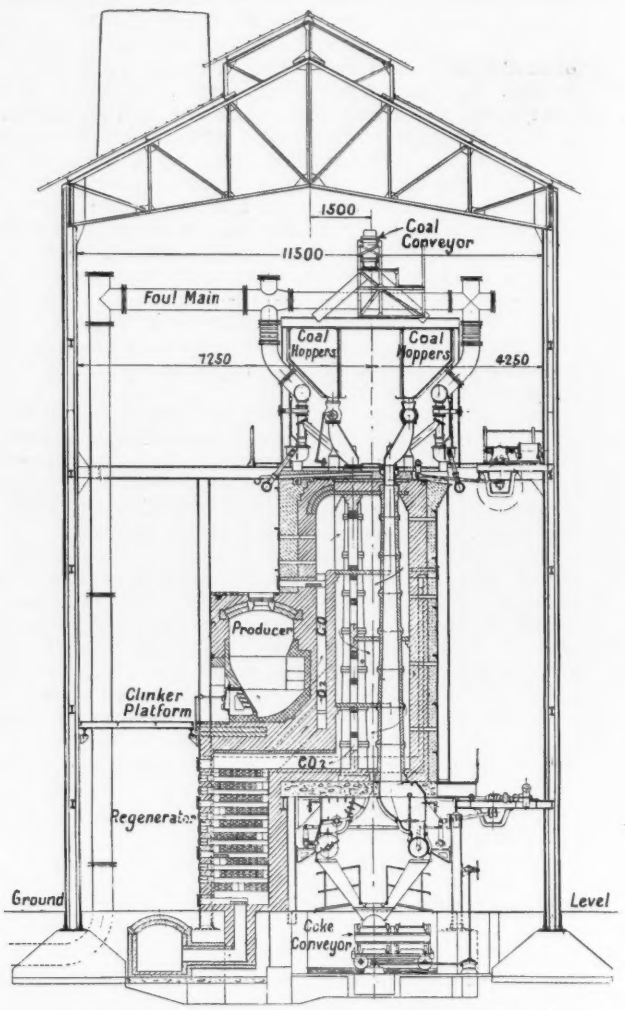
Continuous carbonization of coal is an ideal to the attainment of which many gas engineers have looked forward for some years. The writer, in 1908, after Mr. Harold W. Woodall read his paper on "Continuous Carbonization in Vertical Retorts," determined to examine carefully into the system as worked at Bournemouth, and eventually decided that the difficulties had been so far met that he might safely recommend his Committee to adopt this system in the new retort-house then being erected. He will not dwell on the advantages of any successful method of rendering the operation of carbonization continuous.

It is evident that the sudden change of temperature in the retorts, and the great changes in the quality and rate of production of gas, associated with the dumping of quantities of coal into a hot retort, together with the discharge at intervals of large quantities of red-hot coke, are things which it is desirable to avoid, if it is economically possible. What are the difficulties in the way, and how are they to be overcome? The operation may be conveniently divided into three parts: (1) The admission of the coal; (2) the egress of the coke; and (3), the actual passage of the coal and products through the hot retort during the process of carbonization. They are mentioned here, not in the logical order of occurrence, but in that in which the writer proposes to deal with them.

(1) *Admission of the Coal.*—The coal may be admitted either by mechanical means in small quantities at short intervals, or by a store replenished at longer intervals; the coal finding its way by gravity into the retort, as there is room for it. The first of these methods is that which was adopted at Burnley; being practically the arrangement described by Mr. Woodall in the paper referred to. It has the disadvantage of requiring shafting and mechanical arrangements working in the warm and dusty atmosphere of the top of a retort-bench. It has, moreover, the perhaps greater fault, that if in any way the contents of the retorts drop, an empty space is left which is not so rapidly filled with coal as in the second arrangement. The causes and effects of this will be referred to later. On the other hand, it appealed to the writer because the flow of the coal could be readily observed, and any irregularity quickly detected. Experiments have been made at Burnley with an arrangement in which the feed-roll is elevated somewhat from the retort—thus providing a small store of coal between the feed-roll and the retort. This alteration is found to conduce to more regular working. The drawing given of the



Sections of the Woodall-Duckham Vertical Retorts at the Lausanne Gas-Works.



Cross Section of the Woodall-Duckham Vertical Retorts at the Lausanne Gas-Works.

installation erected at Lausanne illustrates the principle of this. It is also found advisable to have a partition plate between the coal feed and the gas off-take; so that the coal may find its way into the hot part of the retort before the outflowing gas has had any opportunity to deposit in the coal pitchy matter tending to impede its easy flow. The second arrangement, obviating the automatic mechanical feed, is illustrated in fig. 2, which shows the method adopted in the most recent installations. A box is connected to the top of the retort capable of containing two or three hours' supply of coal, replenished at intervals from the overhead bunkers through what is practically a simple plug-cock. It is found possible to arrange in this box a simple indicator, by inspecting which the downward movement of the coal may be observed.

(2) *Egress of the Coke.*—The extraction of the coke is more important, and has presented more difficulties to inventors, judging from the various contrivances which have been patented from time to time. The discharge through a water seal was proposed in the very early days of gas-making, and was that adopted in the early experiments at Bournemouth. Coke, however, is so important a residual that its treatment must be carefully considered. Methods involving crushing the coke, or immersing it in water, must be avoided.

The regularity of the carbonization and uniformity in the make of gas depend on the evenness with which the coke is extracted from the carbonizing chamber. The method adopted to achieve this result was briefly described in Mr. Woodall's communication in 1908, but is worthy of detailed description. The coke rests on the curved side of a cast-iron prolongation of the bottom of the retort, and is prevented from sliding off this by a shaft carrying projecting arms. These arms are arranged spirally along the shaft, so that their rotation shall not bring the coke down simultaneously along the whole width of the retort. It will be seen from an examination of the drawing that there is no tendency on the part of this extractor to break the coke small—pieces 10 inches in diameter readily passing through.

Just over the extractor, a number of swinging weights are suspended to act as a slight check if from any cause the coke has a tendency to run too quickly. The extractor shaft is driven by a wedge-pawl working in a grooved wheel. This gives an impulse twice a minute—being worked from a rocking shaft extending the length of the bench. The throw of the pawl is adjustable by a screw in the arm attached to the rocking shaft. The extractors make a complete rotation in from 45 to 55 minutes. When the coke has passed the extractor, it falls into a discharging drum similar in principle to the feed-roll, but, of course, of much larger dimensions. Actuated by a simple form of self-reversing pawl, worked from the same rocking shaft as the extractor, the discharging drum makes a backward and forward movement about four times per hour—alternately receiving the coke which has passed the extractor and discharging it either into barrows placed to receive it or on to a conveyor.

The long rocking shaft driving the extractor and the discharging drums has at Burnley given considerable trouble; the torsion caused by the discharging drums not working freely resulting in irregular working at the different parts of the bench. This has been remedied in the Lausanne installation by the better design of the rocking-shaft and its method of support, as well as by a slight modification of the discharge drums, causing them to work more freely and yet certainly. In more recent installations, it has, however, been possible to replace the rocking-shaft by a reciprocating rod, which is not liable to the same faults.

A further improvement adopted on two of the retorts at Burnley is to replace the mechanically worked discharging drum by a water-sealed door shown on diagram No. 2. The writer hesitated considerably to adopt a single door of this description, as he was afraid that the admission of air to the retort might lead to explosions. If, however, a little water is admitted before opening the door, the space above the door becomes full of steam, which acts as a cushion between the gas and the air. A small trickle of water is admitted

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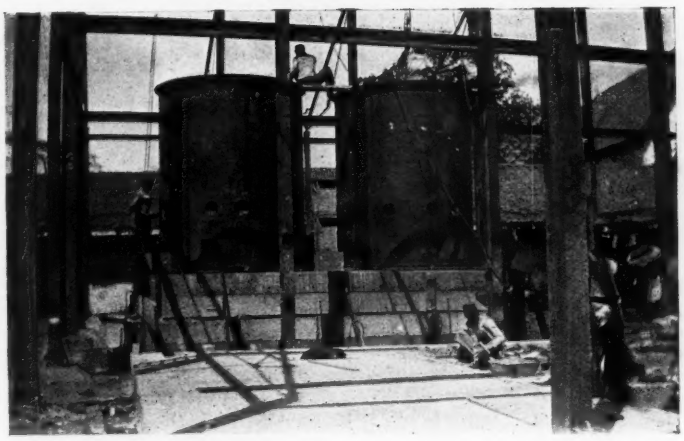

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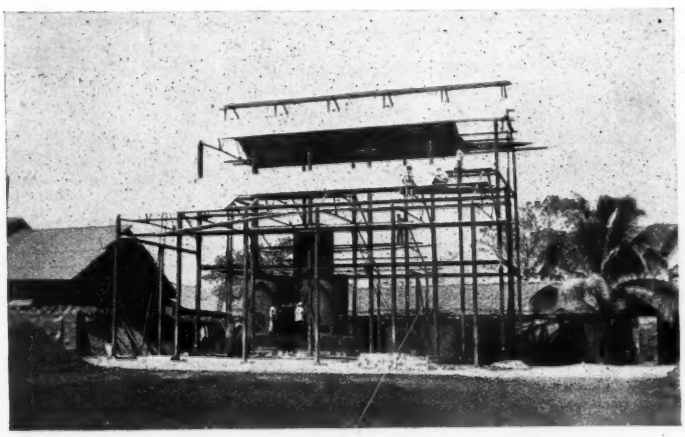
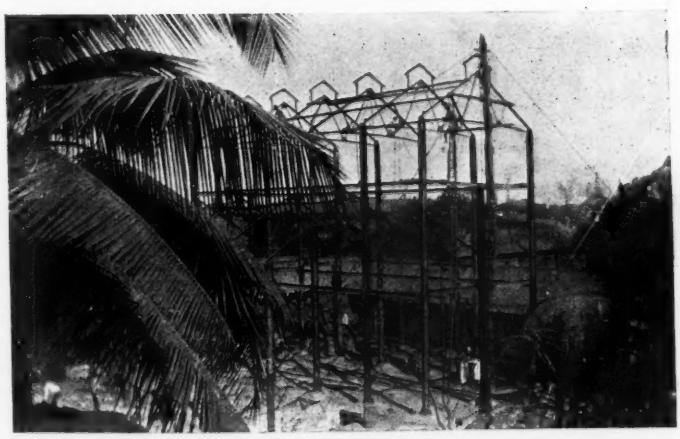
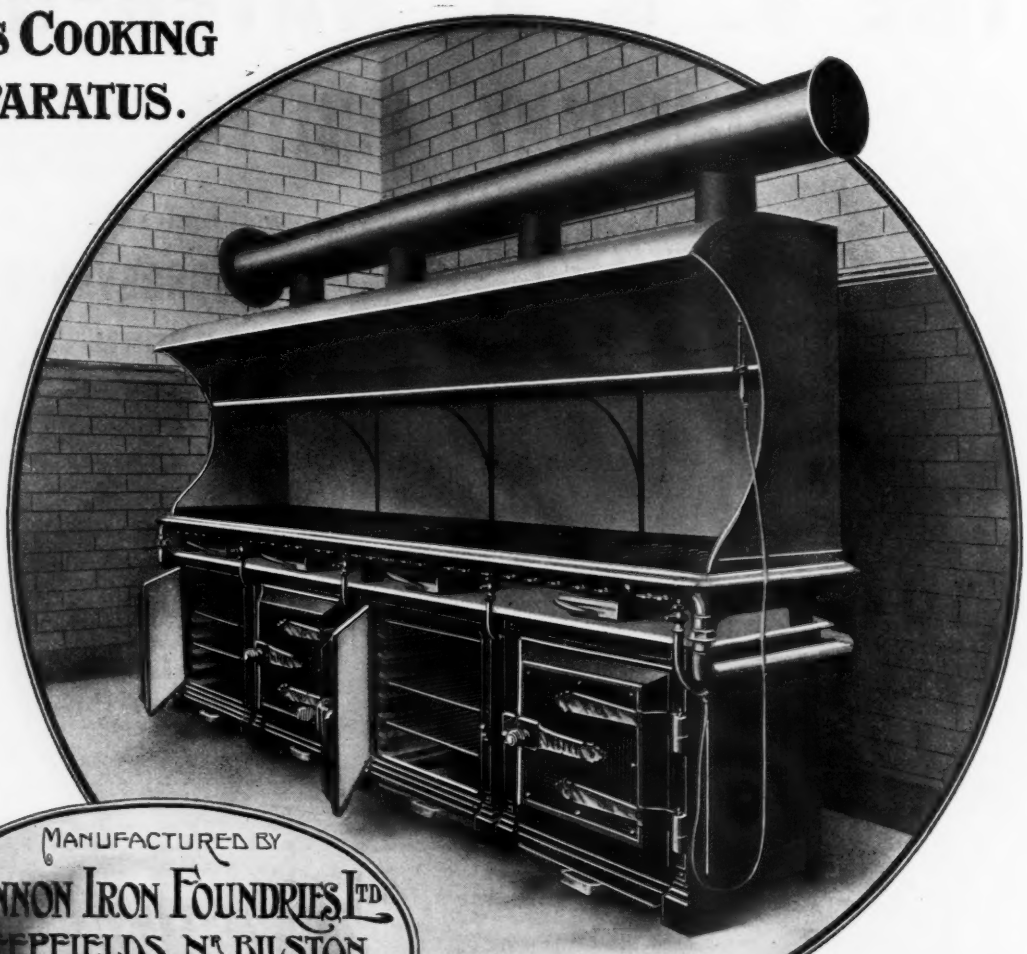




ESTIMATES FREE.

INSTALLATION OF
GAS COOKING
APPARATUS.



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into the coke-chamber in all cases for cooling purposes. Its small effect on the coke, and the character of the coke itself, may be judged from the fact that analyses of the coke have repeatedly shown less than 0·5 per cent. of water, and not more than 0·8 per cent. of water and volatile matter combined.

(3) *Passage of Coal and Products through Retort.*—It is in the passage of the coal and coke through the hot retort that the difference between intermittent and continuous carbonization becomes more evident. In the ordinary process of intermittent charging, the coal in the retort remains where it has been placed, while it passes through a tarry or pasty condition until it is completely coked. As it reaches its thoroughly spent condition, it in most cases shrinks slightly, and is thus readily dealt with for removal. In continuous working, it must, however, be subject to removal during the whole of the time. Though in the vertical retort gravity is always helping it downwards, it is evident that such a gentle force may readily be impeded in its action. The retorts must therefore not only be tapered considerably, but be preserved in good shape and free from ledges or any marked roughness on the interior surface.

Unfortunately, at Burnley there occurred considerable expansion on first setting the installation to work, and from this and other causes many retorts suffered very much. The result has been trouble due to an abnormal amount of hanging-up of the charge. The fact, however, that some of the retorts can be got to work freely with very little attention shows that the system itself is not at fault. When, however, the charge hangs-up, a series of troubles arise. Of these troubles the writer desires to speak freely, because, though they have been experienced at Burnley, they are by no means inevitable, and anyone now adopting the system may avoid them by taking reasonable precautions.

The charge may stick in the upper part of the retort where the contents are of a tarry or pitchy consistency. This can readily be remedied by the occasional insertion of a short rod. If the hanging-up occurs lower down the retort, due to the coke catching on some unevenness in the retort, or owing to previous neglect having caused green coal to get too far down, the trouble is more difficult to remedy, as longer rods have to be used. If the hanging of the charge persists for any length of time while the extraction of coke from the bottom is allowed to continue, when the obstruction is remedied there is at once a fall of the coal, resulting in an empty space in the upper part of the retort. Under these circumstances, the gas given off by the charge passing through the empty part of the retort is overcracked, resulting in the deterioration of the gas and the formation of pitch in the foul main, and possibly a stoppage in the gas off-take pipe. These pipes at Burnley are only 4 inches diameter. They would be better somewhat larger. Those at Lausanne are 5 inches.

The pressure in the retort with normal working is maintained at slightly below, or about, level gauge throughout the length of the retort. There is practically no difference in pressure between the top and the bottom of the retort, except under the circumstances named above, when green coal has been allowed to get low down in the retort.

It will be understood that the writer is not in a position to give accurate figures of make and quality of gas, inasmuch as the gas from the vertical retorts has been purified and measured along with other gas. He has, however, satisfied himself that retorts in fair condition are capable of carbonizing 52 to 55 cwt. of coal per retort per day, yielding 12,600 cubic feet of gas per ton from Burnley coal. The coke is of excellent quality, and being sold by weight is good value to the purchaser, in consequence of the very low percentage of water to which reference has already been made. The tar has a very low percentage of so-called "free carbon." Analyses show no more than 56·8 per cent. of pitch (above 350° C.) and 5·6 per cent. of free carbon.

The writer is able to supplement these results by information as to the working of the installation of similar retorts at Lausanne. Last month he spent some time on the works there, examining carefully their working, and by the courtesy of M. Cornaz, the Gas Engineer of the Lausanne Municipality, was allowed full access to their records. The works there are entirely new, and in all parts reflect great credit on the engineer. The retort-house is entirely fitted with vertical retorts in twelve beds of four each, only one-half of which, however, have as yet been required to be worked. The retorts themselves, and the mechanical arrangements for feed and discharge, are in all important respects similar to those at Burnley. Various kinds of coal have been used.

Some of the results, abstracted from the records, are given in the following table:—

Dates.	Coal.	Cubic Feet per Ton.	Calorific Power B.Th.U. per Cub. Ft. 15° C. and 760 m.m.	
			Gross.	Net.
Feb. 12 to 14	Aldwarke	12,863	623	558
Feb. 15 to 28	Saar	13,180	617	551
April 29 to May 11. . .	Charlesworth	12,648	607	546
May 14 to 17	Rother Vale	13,457	603	537

The figures are taken from the daily records for those periods in which one particular kind of coal was being used. At other times, various different kinds were in use at one time.

To conclude, continuous carbonization has been proved feasible; and as the conditions of smooth working are now demonstrated, it ought before long to take the place of the cruder intermittent method in all new works.

THE SCIENTIFIC CARBONIZATION OF COAL.

By J. G. NEWBIGGING, M.Inst.C.E., of Manchester.

The gas industry has often been charged with conducting its gas-manufacturing operations—particularly with regard to the distillation of coal—in an unscientific manner, and with having effected no fundamental change in this branch of its methods since the days of Murdoch. It cannot be gainsaid that there is much truth in these assertions.

What process is more crude than the dumping of a heap of coal into a retort, whether horizontal, inclined, or vertical in form, and allowing it to "stew" for periods ranging from four hours to twelve hours; then removing the resultant coke, and repeating the process? The effect of this crude method of carbonizing coal is that the gas issuing from the retort differs during every hour of the period of distillation, in illuminating power, composition, and calorific value; and the only means the gas manufacturer has of maintaining a uniform quality of gas is by mixing it in the gasholders—admittedly an unsatisfactory and unreliable method.

Dr. Colman, in his admirable lecture on the "Chemical Aspects of Carbonization," delivered at the Manchester University in December last year, shows the extent of this qualitative variation in his table detailing "The Composition of Gas Produced at Different Stages of Carbonization in Horizontal Retorts;" and this must be characteristic, to a greater or less degree, of all intermittent systems of coal carbonization.

It will no doubt be urged that, in practice, owing to every retort in action not being charged simultaneously, the evil effects of intermittent carbonization are more apparent than real, and that with ordinary care the quality of the gas sent into the distributing mains can be kept fairly constant. To whatever extent this may be true, it does not constitute a sound argument against the abandoning of (to put the point strongly) a thoroughly unscientific system for one possessing the merit of being more scientific, under absolute control, less dependent on the human element for its operating efficiency, and carrying in its train many demonstrably economic and other advantages.

Intermittent systems of carbonization are all very well where the production of coke and other residuals is of primary importance; but it must not be forgotten—and the writer would emphasize this particularly—that the future success of the gas industry depends upon the supply of an unvarying quality of gas during every hour of the day; and if the industry is to maintain its position in the keen competition for the supply of light, heat, and power, it must avail itself of methods of manufacture having that end in view. Gas engineers are indebted to Messrs. Woodall and Duckham and to Messrs. Glover and West for the opportunity they have given them, through their systems of continuous carbonization in vertical retorts, to emancipate themselves from the stigma of being connected with an industry pursuing unscientific methods, and at the same time, by the adoption of these scientific methods of manufacturing gas, to reap all their inherent collateral advantages.

It is generally realized that any considerable expansion of the consumption of gas in the future must necessarily be looked for in other directions than the field of lighting,

especially in the more general displacement of solid fuel by gaseous fuel for all domestic and industrial purposes for which heat is required. A persistent crusade against the smoke fiend is being prosecuted in every large town; and the advantages of the use of gaseous fuel as a weapon to combat this evil are being continually brought to the notice of the public. In participating in this crusade, it must not be forgotten that, with intermittent systems of carbonization, the gas industry contributes its quota to the pollution of the atmosphere; and gas engineers would very materially strengthen their position as advocates of the suppression of the smoke nuisance by setting a good example to other industries in the conduct of their own.

The adoption of continuous carbonization in vertical retorts effects a complete cure to the generally disagreeable conditions prevailing in retort-houses and their vicinity where other systems of carbonization are in vogue, owing to the emission of smoke, steam, flame, dust, &c. This feature alone will, undoubtedly, appeal to the progressive mind. Although the production of an almost absolutely uniform quality of gas during every hour of the day, and the avoidance of nuisance, are outstanding features of the continuous system of carbonization, they by no means exhaust its advantages over any intermittent system; and to these further advantages point will be given in the course of this paper.

The purpose of the present paper is not, however, to theorize or generalize on carbonization questions, but to give an account of the experiences derived, and the working results obtained, by the scientific carbonization of coal in an installation of Glover-West vertical retorts at the Droylsden station of the Manchester Corporation Gas Department, in the hope that the information may be some guide to those engineers who are considering the question of the system of carbonizing they should adopt in their future extensions or reconstruction of carbonizing plant.

Fig. 1 shows the general plan of the Droylsden works, and the position of the new retort-house and coal-store.

The carbonizing capacity of the works—the smallest of the four manufacturing stations of the Gas Department—is 500,000 cubic feet of gas per twenty-four hours; and prior to the installation of the Glover-West system of continuous carbonization, the whole of the gas was made with inclined retorts. After the vertical retort plant was put into operation, the manufacture of gas in the inclined retort-house was discontinued; and since the new plant has been in operation, the whole of the gas at these works has been made by the new process. This circumstance has given

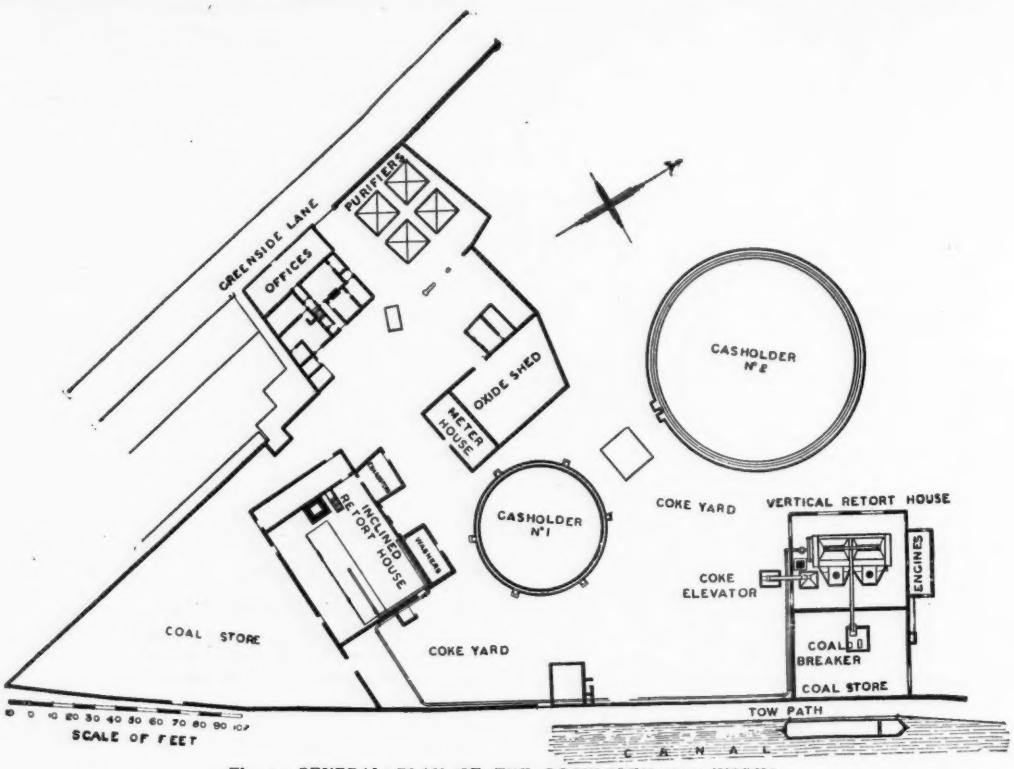

Fig. 1.—GENERAL PLAN OF THE DROYLSDEN GAS-WORKS.

the author a complete opportunity for making a thorough investigation.

The foundations for the installation were commenced in January, 1910; and gas making began on July 12, 1910, so that the retorts have now been in operation nearly twelve months. From the date named, they have worked perfectly satisfactorily, and with the utmost smoothness; and, moreover, all the advantages predicted by the inventors and expected by the author have been realized.

As the entire make of gas at these works passes through the purification plant to the gasholders without mixing with the gas made by any other system of carbonization, the most accurate analyses of the gas and of the bye-products can be, and have been, recorded; thus allowing comparisons to be made with the system of carbonization previously in operation at these works, and also with the results of the horizontal and inclined retorts at the other works of the Gas Department.

Description of Plant and System of Carbonization.

The following is a brief description of the plant and carbonizing system; and in order to assist in making the description clear, several drawings and illustrations from photographs have been prepared.

Fig. 2 is a sectional elevation of the vertical retort-house and coal store.

The Retort-House and Coal Store.—The retort-house is a steel-framed brick-panelled building, which method of economical construction is particularly applicable to an installation of vertical retorts, and is now very generally adopted. In the design of the retort house, advantage was taken of the fact that the building was not to support heavy stage floors or machines; and, consequently, there is no necessity for it to be of the same massive construction as ordinary retort-houses—it only being essential to provide sufficient strength in the structure to support itself, and to withstand the wind pressures to which it may be subjected. Incidentally, it may be of interest, in connection with the retort-house at Droylsden, to state that, during its construction and since its completion, it has been exposed to some very heavy wind pressures, as the building is in an exposed situation.

Regarding the structural features of the house, it is 56 feet long by 44 ft. 6 in. wide, and is constructed of steel braced stanchions, bolted to concrete foundations at their base, and at the upper end to girders spanning the width of the retort-bench, and resting on the top of the main buckstays. The stanchions are stayed horizontally by girder stays and

by diagonal bracing. The spaces between the stanchions are built up with brickwork, 4½ inches in thickness, and openings are left for light and doorways.

The coal store adjoins the retort-house, and is 56 feet long by 40 feet wide. Its walls are 15 feet high, and it is covered by a single span roof of steel principals and galvanized corrugated iron.

At one end of the retort-house there is an extension which forms the house that accommodates the gas-engines for operating both the coal-handling plant and the extractors for discharging the coke from the retorts.

Fig. 3 gives a view of the exterior of the retort-house.

Structural Features of the Vertical Retort Settings.

The installation of retorts consists of one bench of two settings of eight retorts—a total of 16 retorts; the nominal capacity of the plant being 500,000 cubic feet of gas per twenty-four hours, although the daily output has reached 630,000 cubic feet. Each retort-setting is divided into two sections of four retorts each; being so arranged that only half of the retorts in each setting need be under fire in the event of the total output capacity not being required. Each setting is provided with its own producer, from which the producer gas ascends through flues to the combustion chamber; there being an independent flue for each half of the setting.

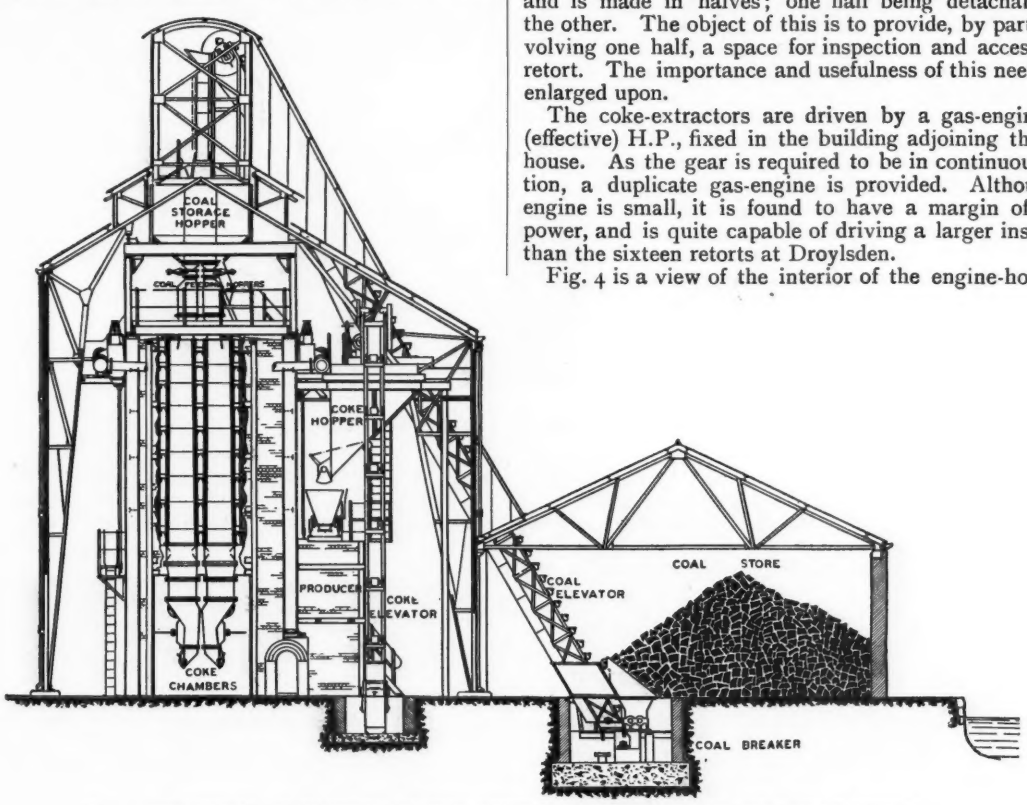

Fig. 2.—SECTIONAL ELEVATION OF THE VERTICAL RETORT-HOUSE AND COAL STORES.

The retorts are oval in section, and measure 30 in. by 10 in. at the top, enlarged to 36 in. by 22 in. at the bottom; and they have a total length of 20 feet each. At the bottom of the retorts is a chamber 3 feet deep, constructed of cast iron, and forming the regenerator portion of the setting. The upper ends of the retorts are heated by the waste gases ascending from the combustion chambers; the gases passing round the top parts of the retorts before entering the passage leading to the chimney.

Coal-Handling Plant.—The coal-handling plant consists of the usual breaker and elevator, which latter is of sufficient height to enable the coal, by means of shoots, to be distributed to the large overhead bunker, which has a capacity for twenty-four hours' supply. This plant is driven by a 17½ (effective) H.P. gas-engine; the power being transmitted to the breaker by means of shafting in an underground tunnel. This arrangement enables the gas-engine to be fixed in the same engine-house as the driving engines for the coke-extractors.

The coal from the large overhead bunkers is delivered into the coal-feeding hoppers, which are placed above each retort, and from which the coal gravitates to the retort at a speed regulated by the rate of discharge of the coke by the coke-extractors (to be described later) at the base of the retorts. Each feeding-hopper is provided with a coal-valve, which is opened at regular intervals for receiving a supply of coal from the storage bunkers—an operation which is very quickly and easily accomplished.

Passage of Gas.—The gas passes off from each retort through an outlet at the side of the base of the coal-feeding hopper, and is conducted by a pipe, 7 inches in diameter, to a dry collecting main, which is provided with a gas and tar outlet, and thence to a foul main. Each outlet pipe is fitted with a valve, which is closed to prevent the return of the gas to the retort when out of action, or when scurfing is proceeding.

A retort-house governor is fixed at the end of the foul main, and serves to maintain a level working gauge, both at the top and bottom of the retorts; a level gauge in the whole length of the retort being one of the notable features of this system of carbonization.

Coke Extraction.—Each retort is fitted with a coke-extractor, which is a slowly revolving vertical worm of a special design, and is made in halves; one half being detachable from the other. The object of this is to provide, by partially revolving one half, a space for inspection and access to the retort. The importance and usefulness of this need not be enlarged upon.

The coke-extractors are driven by a gas-engine of 4½ (effective) H.P., fixed in the building adjoining the retort-house. As the gear is required to be in continuous operation, a duplicate gas-engine is provided. Although this engine is small, it is found to have a margin of reserve power, and is quite capable of driving a larger installation than the sixteen retorts at Droylsden.

Fig. 4 is a view of the interior of the engine-house containing the gas-engines for driving the coke-extractor, the coal-handling plant, and the coke-elevator.

Transmission of power to the coke-extractors is effected by a belt-drive, with a speed-reduction device and reciprocating side rods, from which the coke-extractors are driven by means of levers with ratchet pawls and ratchet wheels; each extractor being fitted with auxiliary speed-varying mechanism. This is a very convenient arrangement; for if it should happen that different classes of coal are being carbonized in the several retorts at the same time, the speed of each coke-extractor can be adjusted to suit the particular coal passing through the retort.

One of the features of this system that appeals to the writer is the complete precaution that has been taken to minimize accidental stoppage. As an example, in order to avoid the risk of a breakdown to the extracting gear, in the event of neglect to discharge the coke from the coke-receiving chambers, or any other cause which would retard or tend to stop the revolving of the worm, a simple and effective safety device is provided.

The coke-extractor does not discharge the coke direct from the retort to the open. There is an intermediary in the shape of a coke-receiving chamber, from which the coke is, in practice, regularly discharged at intervals of two

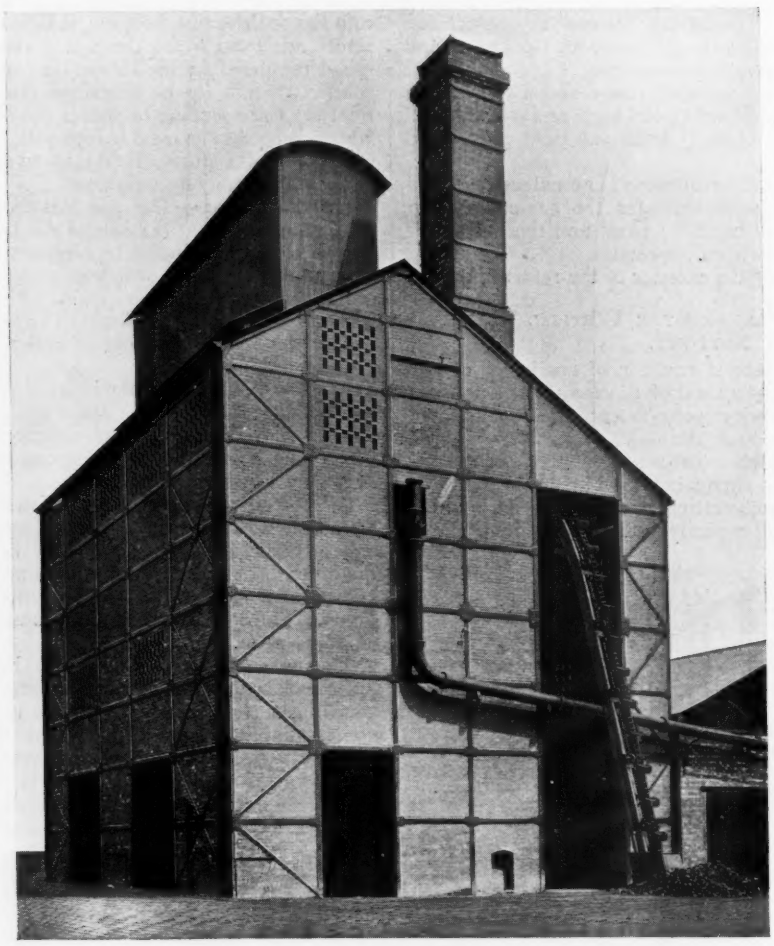

Fig. 3.—ELEVATION OF THE RETORT-HOUSE.

hours, through an outlet with self-sealing lid and fastenings of a similar type to those of the retort mouthpieces of ordinary horizontal or inclined retorts. Each retort is provided with a separate coke-receiving chamber.

Figs. 5 and 6 are from photographs of the coke-receiving chambers and outlets and of the driving gear of the coke-extractors.

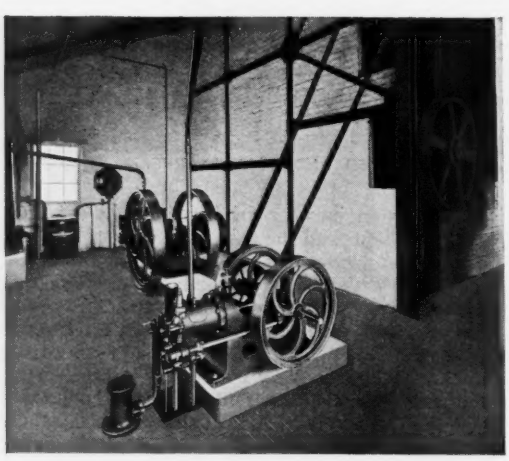

Fig. 4.—Interior of the Gas-Engine House.

Heating the Retorts.—The system of heating the retorts deserves more than passing notice. As already mentioned, each setting is provided with a gas-producer, from which the producer gas is conducted through flues to the combustion chambers. These combustion chambers are in tiers, and are separately heated. The products of combustion, after passing round the retorts, are conducted by vertical flues to horizontal circulating chambers surrounding the top parts of the retorts. In this way the heat of the waste gases is utilized before they pass through the flue to the chimney. After leaving the combustion chambers, the waste gases, on their way to the top circulating chambers,

Fig. 5.—Receiving Chambers and Outlets.

pass through vertical flues adjoining the secondary-air supply flues leading to the combustion chambers; and thus some of the heat is transmitted from the waste gases to the secondary air supply. This enters at the back of the

setting, circulating round the chambers immediately below the retorts—thus becoming heated by the heat transmitted through the walls of these chambers from the coke prior to its removal by the coke-extractors.

This means of regeneration, in conjunction with the extraction of the heat from the waste gases on the way to the

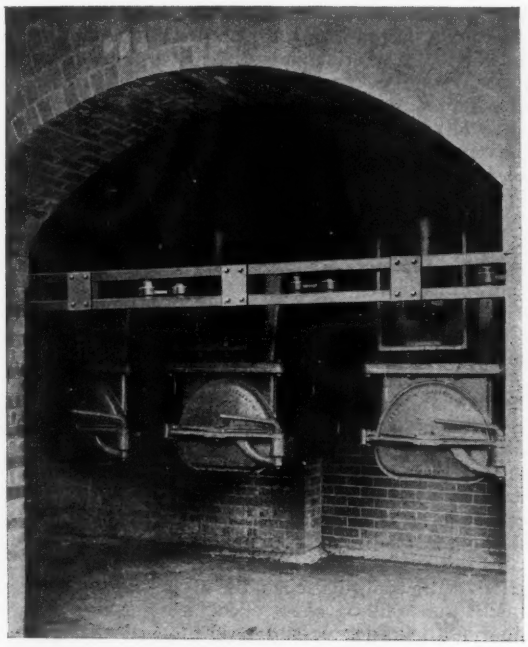

Fig. 6.—Driving Gear of the Coke-Extractors.

circulating chambers, is very effective, inasmuch as it not only cools the coke to such an extent that no quenching is required, but it produces very considerable economy in the fuel account. A series of fifteen tests carried out on various classes of coal shows the fuel account only averages 10·04 per cent.; and the writer thinks it will be admitted that in this system there is a heat utilization efficiency that shows distinct progress in method, combined with saving in labour, and the nuisance attending quenching of coke as ordinarily practised. No trouble or anxiety is experienced in maintaining the required heat. The plant has worked for weeks without the necessity of any adjustment whatever; the design of the settings being the fruit, no one will dispute, of long experience in the science of carbonizing.

The producer furnaces are fed every four hours; and the fires are pricked-up every two hours. They do not require clinkering more frequently than every twenty-four hours; but on certain classes of coal they run without clinkering up to 72 hours.

There is one point more to make the description of the plant complete. An elevator raises the coke to a storage hopper for supplying the travelling producer-furnace filling shoot; and it also reaches to the level of the top of the retort-bench for raising the coke required for filling the retorts when the plant is either started-up to work or after scurfing. This coke-elevator is driven by gearing from the coal-elevator drive; and clutches for throwing either elevator in and out of gear are provided.

Fig. 7 is an illustration of the producer-furnace filling shoot, which is fitted with lid-lifting gear and bottom discharge door.

Cost of Plant.—It is very difficult to lay down a definite figure regarding the cost of vertical retort installations worked on the continuous systems, as the circumstances and conditions and the cost of construction vary so much in different localities. The writer will, therefore, give the cost of the plant at the Droylsden Gas-Works only.

The total cost for the complete installation, including foundations, retort-house, and bench, with all fittings, coal and coke handling plants, with driving engines and house, was £8150, which works out approximately to £180 per ton of coal carbonized per diem. The average output of the plant is 500,000 cubic feet per twenty-four hours, although on a number of coals this output has been considerably increased. For a larger unit, equipped with coke-handling machinery, no doubt the initial cost will work out considerably less, and, the writer believes, will compare favourably with modern installations of horizontal retorts with stoking machinery correspondingly equipped, which cost £140 to £160 per ton of coal carbonized per diem.

Labour Costs.—The economy in labour costs effected by the continuous system, combined with the advantages gained by more agreeable conditions of labour than prevail in a retort-house with intermittent systems, results from a comparatively few men being fully employed in attending to the plant. The actual figures referring to the comparatively small installation at the Droylsden works are as follows:

Labour Costs in the Droylsden Retort-House per Twenty-Four Hours, Based on the Carbonization of 45 Tons per Day.

	s.	d.
Three men per 24 hours at 5s. 3d.	= 15	9
15s. 9d. ÷ 45 tons = 4·2d.	Total labour cost per ton of coal, within the retort-house.	

With an installation dealing with 100 tons or more per day, and with the introduction of coke-handling machinery, the foregoing figure would, there is no question, be very considerably reduced. One man undertakes the whole of the work within the retort-house during each shift of eight hours. His duties include the regulating of the coal to the bunkers from the elevator, and from the bunkers to the retort-feeding hoppers, drawing coke from the retorts into barrows, and conveying it to the doorway of the retort-house, cleaning the take-off pipes, and clinkering furnaces. No intermittent system of carbonization, with horizontal or inclined retorts, can show such low costs for so small a quantity of coal dealt with per day. Therefore, the system, it may be assumed, is equally suitable for small or large plants.

The cost of power, which in this case is derived from gas-engines, is as follows:—

Coke Extracting.

34 cubic feet of gas used per ton of coal carbonized at 1s. 9d. per 1000 cubic feet . . . . . = 0·714d.

Coal Breaking and Elevating and Coke Elevating.

32 cubic feet of gas used per ton of coal and coke elevated at 1s. 9d. per 1000 cubic feet. . . . . = 0·672d.

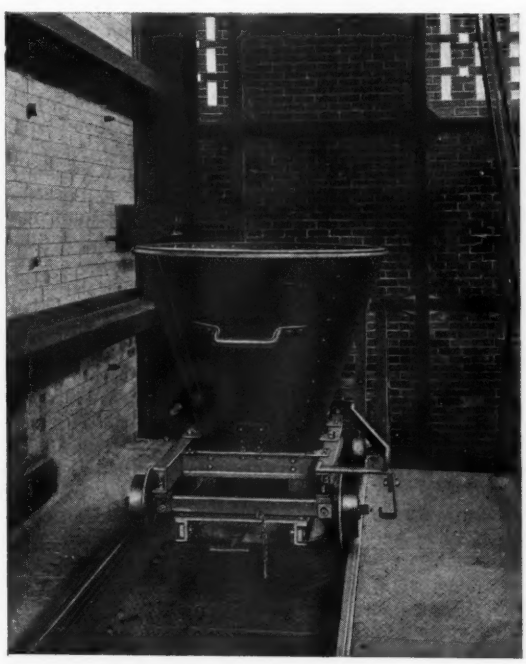

Fig. 7.—Producer-Furnace Filling Shoot.

Wear and Tear and Maintenance.—On the question of wear and tear, there is abundant evidence from the experience gained at Droylsden, and, also, the writer understands, from the more extended experience at St. Helens, that the wear and tear and cost of renewals will be very considerably less than with other carbonizing plants, as, beyond the coal-handling plant, a very small amount of machinery is required

to operate the few mechanical movements; and the mechanism itself is very simple, substantial, and slow moving.

The fact that the whole of the structure of the retort-setting is practically in compression—the vertical position in itself being an ideal one for the setting of a retort, and the temperature of the retorts being more constant than with intermittent systems, which necessitate the retorts being frequently opened and subjected to rapid cooling—indicates that the retorts will have a long life. There appears, in fact, to be no legitimate reason why the retorts should not have a life in excess of intermittently-worked ones. The retorts at St. Helens—the only installation on the Glover-West system from which any positive conclusions in this respect can yet be drawn—have now been working over 1000 days; and they are still in excellent condition, and likely to work for a further extended period.

In another direction, economical wear and tear of plant may be anticipated. As the coke by this system is discharged from the coke-chambers in a cool state, it is not so destructive to whatever type of coke-handling plant may be employed—either conveyors, waggons, or barrows; and this must have a marked effect on the depreciation of such plants, and, consequently, on the cost of wear and tear. Again, as the principle of the operation of the plant is due to the natural gravitation of the coal through the retorts, the mechanical operations are few in number, and there is a minimum risk of delay through the breakdown of machinery. As previously stated, in order to minimize the risk of an overload on the driving gear, in the event of neglect to discharge the coke from the coke-chambers at regular intervals, automatic safety releases are provided; and there is a reserve engine for driving the coke-extractors.

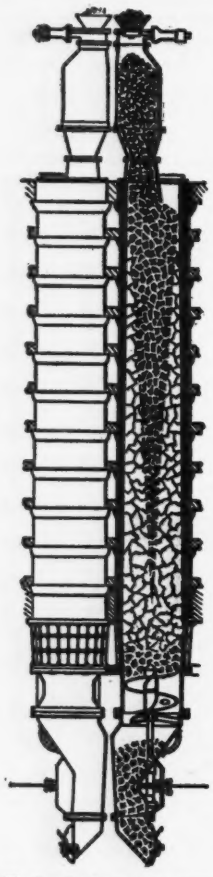

Fig 8.—Coal passing through Vertical Retort.

Notes on Working.—There are a few miscellaneous points, affecting the working, which, though minor in importance are of sufficient practical interest to introduce at this stage. In the first place, the gas off-takes are provided with covered inspection holes, which are easily removed for cleaning purposes. In practice, very little cleaning is required—in fact, only once in the twenty-four hours is the auger put through the pipes. This unaccustomed ease with the pipes is no doubt due to the regular flow of tar and liquor of uniform quality. Facilities are also provided in the collecting mains for removing any thick tar that may have collected. When coal is passing through vertical retorts working under the continuous process, the core of the charge is not completely distilled until it arrives at the base of the retort; and it really takes the form of a wedge, as illustrated in fig. 8. The travel of the coal from its entrance into, and exit from, the retort occupies approximately twelve hours; and the quantity of coal carbonized per retort per twenty-four hours has ranged from 50 to 64 cwt., according to the class of coal.

Advantages of Continuous Carbonization.—Upon entering the retort-house, one immediately notices the smooth and noiseless working of the plant, the cleanliness of the retort-house, and the complete absence of all the disagreeable conditions of labour which prevail with other systems of carbonization. In consequence, there is a considerable advance in the improvement of the sanitary conditions of retort-house labour. This improvement is very evident to all who have any consideration for the amelioration of the arduous duties of those who are engaged in retort-house work. The coal, after being elevated to the overhead bunker and fed to the coal-feeding chamber, is completely enclosed in the carbonizing apparatus until it is discharged as cold coke from the receiving chambers below the retorts to the barrows for conveyance to the yard. There is thus complete absence of smoke and flame. The plant, in short, is self-contained, even to the extent of being self-preventive of nuisance by not contributing to those conditions that are responsible for the fouling of the atmosphere of retort-houses, as is commonly the case.

The large yield of gas made in a retort-house occupying a small ground area is another of the conspicuous features of the new system when compared with the area required for a similar output from a retort-house equipped with either horizontal retorts and machinery or inclined retorts; and this advantage alone is valuable in works where there is but a limited area available for extending the carbonizing plants, and where land is expensive. The perfect control of the temperature throughout the entire length of the retort, and the ready means for regulating the speed of the coal passing through the retort, facilitate the adaptation of the plant to any class of coal.

A greater yield of gas per ton of coal is effected by the continuous system of carbonization; the increase, of course, varying from different classes of coal. The writer finds that from 500 to 1000 cubic feet more per ton are obtained than by the systems of carbonizing employed at other stations of the Manchester Corporation when using similar coals and maintaining the same illuminating power.

The comparisons made between the several systems and the new installation, when the same class of coal is used, are, beyond all question, in favour of the continuous system of carbonization. The excellent results obtained with the vertical retort installation at the St. Helens Gas-Works (as published) have been surpassed by the Droylsden plant—notably in the further reduction of the low percentage of fuel used in the heating of the retorts. The feeding of the producers with cool, dry coke by means of the specially designed furnace-filling shoot effects a great contrast with the laborious operation prevailing in the feeding of the producers with red-hot coke with the horizontal and inclined retort systems.

The calorific power of the gas made by the continuous system is regular. At the Droylsden Gas-Works, a Beasley calorimeter chart continually records the net calorific value of the gas, which, for testing purposes, is taken from the inlet of the gasholder. The chart shows, by an almost regular straight line, that the calorific value of the gas is remarkably constant and unlike the gas produced from horizontal, inclined, or vertical retorts worked on the intermittent system, in which there is a considerable variation of the calorific value.

Fig. 9 shows a series of charts on which is recorded the calorific value of the gas produced from the Glover-West vertical retorts, in comparison with horizontal retorts and inclined retorts, over a period of twenty-four hours. It will be seen on examining these charts that, with intermittent carbonizing in horizontal retorts, the difference between the highest and lowest recorded calorific values of the gas is 88 B.Th.U., or 14·91 per cent., and in the case of the inclined retorts, 168 B.Th.U., or 27·54 per cent.; whereas, by continuous carbonizing in vertical retorts, the same calorific value throughout is maintained as near as possible. A recording calorimeter is of the utmost value in working vertical retorts, as it indicates immediately any variation that may occur in the process of carbonization.

The flow of gas from the continuously-operated vertical retorts is regular in quantity and quality, and, in consequence, the auxiliary gas-plant works more regularly and smoothly than with the intermittent systems of carbonization. At the Droylsden Gas-Works, the condensers, the washers and scrubbers, and the purifiers are barely of sufficient capacity to pass 500,000 cubic feet of gas per diem with the intermittent system; but with the continuous system of carbonization, it has been possible to pass as great a quantity as 630,000 cubic feet without difficulty. It is seen that the continuous, compared with any intermittent, system of carbonization discloses many advantages in favour of the former. With the intermittent system, it appears to be the general custom to place a regular weight of coal in a retort for a regular period without any regard to the varying time in which different classes of coal liberate their gas; and therefore in many instances there must be under or over carbonization, with the result, in the latter case, that there is an increase in those constituents of the gas which it is the aim of every gas engineer to avoid. With the continuous system, the speed of discharge can be readily adjusted to suit the variations; and with the many different classes of coal used in Manchester, it is clearly

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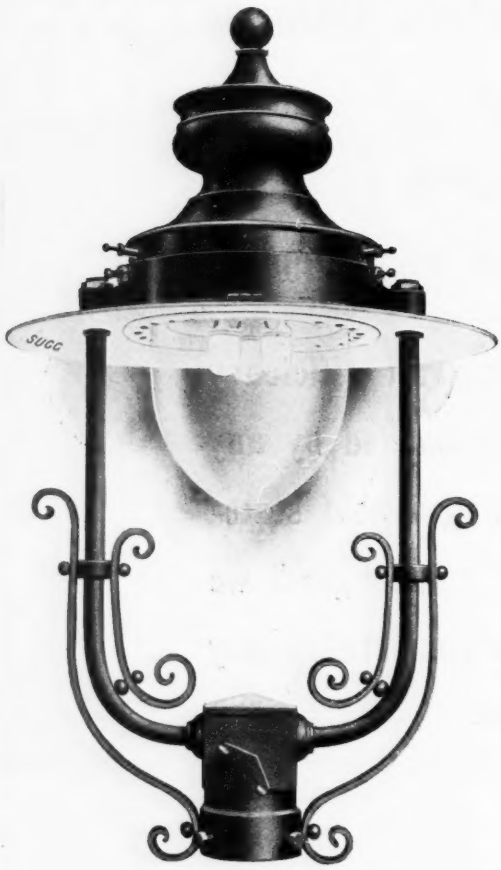

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RECORDS TAKEN WITH BEASLEY'S RECORDING CALORIMETER.

Showing the Variation in the Calorific Values.

Horizontal Retorts with Stoking Machinery.	Glover-West Vertical Retorts.	Inclined Retorts.
When Making 11,155 Cubic Feet per Ton.	When Making 13,033 Cubic Feet per Ton.	When Making 11,645 Cubic Feet per Ton.

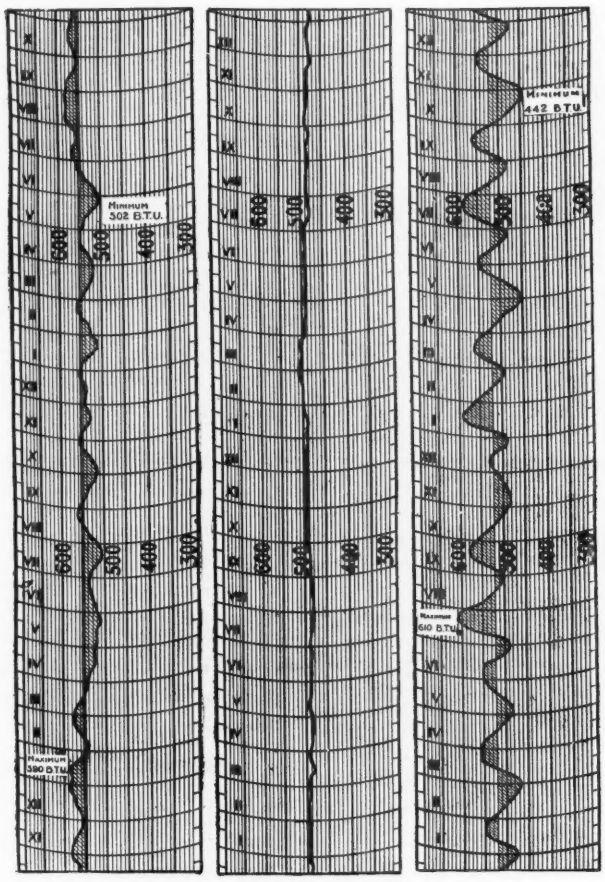


Fig. 9.—Charts of Calorific Value.

demonstrated that the time occupied for complete distillation varies to a considerable extent—the quantity of coal carbonized in the plant differing, in fact, to the extent of 10 tons per day.

In this connection, it may be of interest to note the behaviour of various coals when testing for volatile matter (see fig. 10). No. 1 is coke from Lancashire coal, which, it will be observed, has not swelled to any great extent. No. 2 coke is from Yorkshire coal, which swells considerably, and produces, as would be expected, a very dense coke. No. 3 is from Derbyshire coal, where practically no swelling takes place. Knowing the behaviour of the coal in the laboratory when carrying out these tests, one is able in practical working to regulate the speed of discharge of the coke to suit the material being dealt with.

From the comparisons that published information have made possible, the quantity and quality of gas and residuals produced per ton of coal carbonized with the continuous system here described are not surpassed by those obtained by any other method of carbonizing. In addition to this, the system shows certain definite advantages over any other, which may be summarized as follows: 1. Larger yield of gas made on a given area. 2. Absence of nuisance in retort-house and neighbourhood. 3. Better working conditions for men employed. 4. Less arduous labour, and consequently lower working costs. 5. Low consumption of fuel for heating the retorts. 6. Absolute control of heats. 7. Adaptation of plant to suit the varying classes of coal. 8. Absolute uniformity of illuminating power, calorific value, and composition of gas. 9. Low maintenance costs of coke-conveying plant.

Working Results.—During the time the retorts have been at work, many different coals have been dealt with; and the table which follows gives a summary of the results obtained with coal from three districts—viz., Lancashire, Yorkshire, and Derbyshire. The figures here given are typical of the results secured during the whole of the working period of the retorts. The coal has been dealt with in two ways. Tests under columns A have been made with the object of ascertaining what quantity of gas of an illuminating power of 17 candles could be obtained under ordinary working conditions; and tests under columns B, to secure a large volume of gas of an illuminating power of 15 candles. The method of conducting the tests was as follows: Sixteen to eighteen hours prior to the commencement of the tests the coal-bunkers were all emptied, and an 18 hours' supply of material placed in them. This run-through was necessary to ensure the retorts and feeding hoppers being full of the test material, and enabled the apparatus and sampling holder to be flushed with gas made from the material under observation. The gas produced during the last eight hours of the run-through was delivered into a smaller holder of a capacity of 70,000 cubic feet.

The test was then commenced with the retorts and feeding hoppers full of the coal to be tested, and the storage bunkers empty. The readings of the station meter, which had been officially tested beforehand for correct registration, were then taken, and all coal placed in the bunkers from this time to the end of the test was weighed on a special standardized weighing-machine. At the end of the test, the conditions were exactly the same—the retorts and the feeding hoppers full and the storage bunkers empty. The state of the meter was again taken, and by these means the quantity of coal carbonized, and the gas made, was arrived at. Regular observations were taken of the barometer and temperature, and the average was used to correct the gas to standard pressure and temperature.

Coke Produced and Used in Producer.—During the period of the test, the whole of the coke discharged from the retorts and that placed in the producers was carefully weighed; the depth of fuel in the producers at the commencement and end of test being exactly the same.

Tar and Ammoniacal Liquor Produced.—Thirty minutes after the commencement of the test, the tar and liquor tanks were dipped and the quantity of tar and liquor in stock calculated; a sample of the liquor being taken and tested for strength. Thirty minutes after the end of the test, the tanks were again dipped, and the quantity of tar and liquor in stock was again ascertained—by this means arriving at the quantity of tar and liquor made. In addition to taking samples of liquor at the beginning and end of the test, samples were taken throughout the test; but the strength varied very little.

Sampling and Testing of Gas.—The gas which had been passed into the small gasholder during the last eight hours of the run through was turned on to the service as soon as the test commenced; and when the holder was empty, the inlet valve was opened, so that about 1000 cubic feet of the gas made per hour passed into the holder—the outlet valve remaining closed. At the end of the test, this sample was

1 2 3

Fig. 10.—Coke produced in Crucible when estimating Volatile matter in Coal.

tested for illuminating power and calorific value, and a sample taken and analyzed. In addition to this examination, the gas was tested several times each day at the inlet of the gasholder, for illuminating power and calorific value, and not less than one sample completely analyzed each day. Cyanogen was estimated during each test at the outlet of the rotary washer, naphthalene at the inlet of the gasholder, and sulphuretted hydrogen at the outlet of the rotary washer. Sulphur compounds were estimated once daily at the inlet of the gasholder.

Summary of Tests with Glover-West Vertical Retorts.

—	Lancashire Coal.		Yorkshire Coal.		Derbyshire Coal.	
	A Test.	B Test.	A Test.	B Test.	A Test.	B Test.
Moisture in coal	1·62 per cent.		1·34 per cent.		1·5 per cent.	
Sulphur in coal	1·53 ,,		1·64 ,,		3·02 ,,	
Ash in coal	3·68 ,,		7·90 ,,		8·70 ,,	
Volatile matter	33·56 ,,		30 00 ,,		31·00 ,,	
Coal carbonized	129·866 tons	140·5 tons	150·38 tons	93·67 tons	130·231 tons	78·98 tons
Gas produced at 60° and 30″	1,541,249 c. ft.	1,831,020 c. ft.	1,813,420 c. ft.	1,333,512 c. ft.	1,508,691 c. ft.	1,126,145 c. ft.
Gas made per ton	11,868 c. ft.	13,033 c. ft.	12,059 c. ft.	14,236 c. ft.	11,584 c. ft.	14,258 c. ft.
Illuminating power No. 2 "Metropolitan"	17·23 candles	15·43 candles	17 01 candles	15·35 candles	17·12 candles	15·38 candles
	Gross. Net.	Gross. Net.	Gross. Net.	Gross. Net.	Gross. Net.	Gross. Net.
Calorific value B.Th.U.	586·6 524·0	551·8 494·1	578·8 516·9	548·2 491·0	582·4 522·8	544·0 489·1
Sperm per ton	701 lbs.	690 lbs.	703 lbs.	749 lbs.	680 lbs.	751 lbs.
Candles per ton	40,897	40,220	41,025	43,704	39,663	43,857
B.Th.U. per ton	6,961,769	7,191,609	6,979,749	7,804,175	6,746,521	7,756,352
Fuel used	9·49 per cent.	9·37 per cent.	10·72 per cent.	12·71 per cent.	9·48 per cent.	10·39 per cent.
Coke per ton, dry	13·8 cwt.	13·7 cwt.	13·4 cwt.	13·64 cwt.	13·58 cwt.	13·1 cwt.
Tar per ton	11·52 galls.	9·41 galls.	12·83 galls.	11·19 galls.	12·1 galls.	11·94 galls.
Ammoniacal liquor per ton, 10 oz.	36·5 galls.	35·9 galls.	22·75 galls.	30·14 galls.	37·81 galls.	40·1 galls.
Ammonium sulphate per ton	30·7 lbs.	30·2 lbs.	19·1 lbs.	25·3 lbs.	31·8 lbs.	33·72 lbs.
Sodium ferrocyanide per ton	—	2·27 lbs.	—	2·95 lbs.	—	2·84 lbs.
Sulphur in purified gas, oxide only	31·05 grs. per 100 c. ft.	32·46 grs. per 100 c. ft.	33·78 grs. per 100 c. ft.	38·1 grs. per 100 c. ft.	23·41 grs. per 100 c. ft.	27·58 grs. per 100 c. ft.
Naphthalene in purified gas	—	2·77 grs. per 100 c. ft.	—	1·98 grs. per 100 c. ft.	—	2·35 grs. per 100 c. ft.
Analysis of Gas.						
Carbonic acid	2·10 per cent.	2·53 per cent.	0·90 per cent.	1·00 per cent.	1·80 per cent.	2·00 per cent.
Oxygen	*Nil*	·27 ,,	*Nil*	0·30 ,,	*Nil*	·30 ,,
Unsaturated hydrocarbons	3·20 per cent.	3·43 ,,	3·60 per cent.	3·10 ,,	3·45 per cent.	3·10 ,,
Carbon monoxide	9·10 ,,	10·70 ,,	6·20 ,,	6·70 ,,	9·30 ,,	10·20 ,,
Methane	31·49 ,,	26·94 ,,	30·40 ,,	28·44 ,,	31·54 ,,	27·54 ,,
Hydrogen	51·18 ,,	52·27 ,,	57·11 ,,	56·06 ,,	52·06 ,,	51·30 ,,
Nitrogen	2·93 ,,	3·86 ,,	1·79 ,,	4·40 ,,	1·85 ,,	5·56 ,,

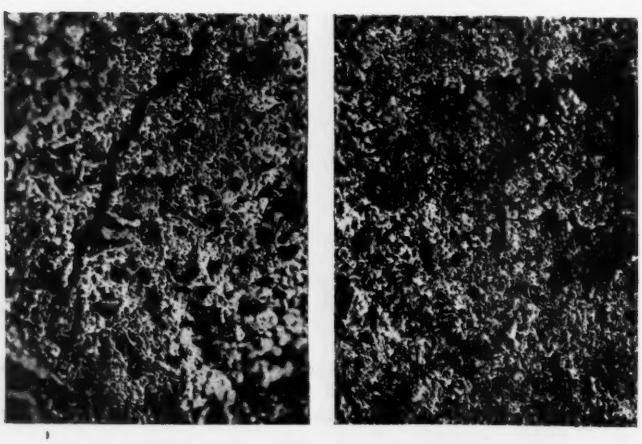
Tests have been regularly carried out to ascertain the uniformity of the gas issuing from the retorts; and the following table shows how constant this is.

TABLE *Showing Uniform Quality of Gas from Glover-West Vertical Retorts.*

Time	a.m. 10.30.	a.m. 11.30.	p.m. 12.30.	p.m. 1.30.	p.m. 2.30.	p.m. 3.30.
Illuminating power. Candles No. 2 "Metropolitan"	15·2	15 35	15·3	15·18	15·52	15·65
Calorific value, gross	548·6	546·6	540·7	554·2	556·2	552·2
Carbonic acid	0·8	0·9	0·8	0·8	0·8	0 8
Oxygen	0·3	0·3	0·3	0·2	0·3	0·3
Unsaturated hydrocarbons	2·8	2·8	2·8	2·74	3·1	3·1
Carbon monoxide	6·3	6·5	6·5	6·10	6·5	6·5
Methane	29·33	28·83	28·67	29·37	29·17	29·17
Hydrogen	56·63	56·82	56·51	57·13	55·60	56·79
Nitrogen	3·84	3·85	4·42	3·65	4·53	3·34
Grains of H_2S at outlet from rotary per 100 cubic feet	600	610	600	600	590	590

PHOTO-MICROGRAPHS SHOWING TEXTURE OF COKE FROM HORIZONTAL AND VERTICAL RETORTS.

[MAGNIFIED TWELVE DIAMETERS.]



Coke from Horizontal Retorts. Coke from Vertical Retorts.

Fig. 11.

For the purpose of comparison, Dr. Colman's table, already referred to, showing the varying quality of gas from intermittently charged horizontal retorts, is given below:—

Composition of Gas Produced at Different Stages of Carbonization in Horizontal Retorts.

Hours after commencement	½ Hour.	1½ Hours.	2½ Hours.	3½ Hours.	5 Hours.
Sulphuretted hydrogen	3·8	3·1	2·8	2·1	1·2
Carbonic acid	3·0	2·8	2·6	2·3	1·7
Ethylene and benzene	8·7	5·2	3·6	2·4	—
Oxygen	0·0	0·0	0·0	0·0	trace
Carbon monoxide	4 3	5·0	4·9	4·5	3·8
Hydrogen	29·8	37·5	42·2	46·2	60·8
Marsh gas	49·7	42·0	39·4	37·5	26·3
Nitrogen, difference	0·7	4·4	4·5	5·0	6·2

Coke.—Apart from the fact that the coke drawn from the retorts is already cooled and in a dry state ready for immediate sale, it will be readily gathered from an inspection of the samples which have been sent from Droylsden that there is a general improvement in its condition and appearance—being clean and bright, and free from dirt and semi-carbonized portions such as are found in coke from horizontal or inclined retorts. This coke has a good sale for general purposes; and the writer has been informed by some users that they much prefer it to that previously produced in the inclined retorts at the works. The smiths also find a distinct advantage when using this coke, maintaining a cleaner fire and enabling them to obtain a good welding heat more quickly.

An examination of the two cokes gives the following comparative figures:—

Comparison of Coke from Vertical and Horizontal Retorts.

	Coke from Vertical Retorts.	Coke from Horizontal Retorts.
Apparent specific gravity	1·079	0·915
Real specific gravity	1·800	1·706
Pores in coke	40·06 p. ct.*	46·37 p. ct.*
Volatile matter	0·69 ,,	3·73 ,,
Evaporative value	13·85 lbs.	13·4 lbs.

* By volume.

Tar.—The following table gives analyses of tars produced from vertical retorts. No. 1 is the tar made when producing high-quality gas; No. 2, when the make of gas was increased and the quality lowered. It will be noticed that in each case the specific gravity is low, as compared with tar from

horizontal retorts; and the writer would direct special attention to the low free carbon.

Analyses of Tar Produced when Carbonizing Coal in Glover-West Vertical Retorts.

SAMPLE NO. 2.

Specific gravity . . .	A Test. 1·074		B Test. 1·146		*Tar from Horizontal Retorts for Comparison.* 1·193
—	Per Cent. by Volume.	Per Cent. by Weight.	Per Cent. by Volume.	Per Cent. by Weight.	Per Cent.
Water	..	..	2·5	2·2	5 0 by volume.
Light oils up to 170° C. .	9·1	7·2	4·6	3·7	4·5 by volume.
Middle oils 170° to 270°.	25·7	22 3	22·4	19·7	12·0 by volume.
Heavy oils 270° to 350° .	24·9	23 0	19·7	18·2	19·5 by volume.
Pitch over 350° . . .	..	46·0	..	55·4	57·0 by weight.
Free carbon	..	3·1	..	5·86	17·67 by weight.

In conclusion, the author makes no pretence whatever to have given anything but a mere sketch of this important question of continuous carbonization in vertical retorts. That the system will eventually be generally adopted, to the exclusion of all other existing crude and unscientific methods, he has not much doubt, not merely because it has just claim to be termed scientific, but because it is commercially superior to any other system.

CARBONIZING SYSTEMS—A REVIEW AND A SELECTION.

By P. C. HOLMES HUNT, of Melbourne.

The city and suburbs of Melbourne are supplied with gas from three manufacturing stations. These works belonged to the three original Companies before their amalgamation and the formation of the existing undertaking in 1878. The works are situated as follows: One at West Melbourne, on the River Yarra, one at South Melbourne some three-quarters of a mile from the Town Pier at which the coal is discharged, the third—the smallest works—at Fitzroy, in the northern suburbs, about three miles from the river side, whence all the coal has to be drawn in lorries. The rapid growth of Melbourne and the great prosperity of the Colony reflected itself on the progress of the undertaking for many years after the formation of the present Company; the make of gas increasing from 631,657,000 cubic feet in 1878 to 1,674,053,000 feet in 1888 and 2,136,631,000 feet in 1891; the latter being the largest output so far recorded in the history of the Company.

The bursting of the "Boom" and the failure of the banks in the year 1891 brought about a reduction in the business; and as the prosperity of the Colony decreased, so the output of gas was very much reduced—the make falling as low as 1,167,900,000 cubic feet in 1897. Attention was drawn to this extraordinary experience—which is probably unique in the history of gas undertakings—in an article published in the "JOURNAL OF GAS LIGHTING" for Nov. 2, 1909. Suffice it to say here that the turn of the tide came in 1902, and with it the necessity of rebuilding the carbonizing plant on modern lines. Consequently, in that year and in 1903, when the author joined the undertaking, installations comprising 41 beds of inclined retorts were erected and put into action at the West Melbourne and Fitzroy works. These additions to the carbonizing plant sufficed to assist matters for a short time; but in 1906, when the writer assumed charge, the reconstruction of another retort-house at the West Melbourne works became imperative. This was carried out with a complete installation of De Brouwer machinery.

Following this, in the years 1907-8, a considerable amount of work was undertaken at the South Melbourne works, when the northern half of the retort-house was reconstructed and twenty beds of horizontals, with De Brouwer charging-machines and coke-conveyors, were installed. It was the intention, on the completion of this half of the retort-house, to proceed at once with the reconstruction of the southern half on similar lines. But, owing to the increased output (the make had increased from 1,308,500,000 cubic feet in 1903 to 1,888,539,000 feet in 1909), it was found impracticable to put out of action, for a whole winter, a number of direct-fired settings which necessarily would have had to be pulled down to admit of the work of reconstruction being carried out. As, therefore, sufficient spare carbonizing plant was not available at any of the stations, it was determined to erect a new retort-house at the West Melbourne works before proceeding with more reconstruction; and having regard to the importance of the proposition, and also to the great advances reported from home regarding the development of vertical retorts, continuous carbonization, and chamber ovens, it was thought advisable to visit and investigate the working examples of these systems before proceeding with any further extensions. Consequently, the author spent some time in Europe during 1910 for this special purpose.

It will be realized that the investigation was not one confined to noting progress made and studying the application of the theoretical principles of the various processes, but was essentially one to determine without delay the definite selection of a plant to be erected forthwith on a considerable scale. The author takes this opportunity of recording his keen appreciation of the courtesy of the engineers of the undertakings where he was enabled to inspect and study the work of the leading examples of the various up-to-date carbonizing systems. In compliance with the invitation of the President of the Institution, the writer has prepared the following notes based on the information collected, and embodying his reasons for the selection made; and if the notes should, in any way, assist in a discussion on the all-important subject of carbonization, he will feel he has offered some small practical return for the assistance he received from members of the gas profession during his tour of inquiry.

ADVANCES IN CARBONIZATION.

The systems under which advances in carbonization have been, and are being, made may be classed as follows:—

(*a*) Vertical retorts worked intermittently.
(*b*) Horizontal retorts worked with full charges.
(*c*) Continuous carbonization in vertical retorts.
(*d*) Vertical retorts worked on the "continuous-intermittent" system.
(*e*) Carbonization in bulk—"chamber ovens."

Intermittent carbonization in vertical retorts, as exemplified by the Dessau installations, forced itself upon the writer as being a thorough and finished system of carbonizing coal; the manipulation of the plant being simplicity itself and, without doubt, fool-proof. He was struck with the advantage of such a system from the point of view of the complete absence of machinery—the latest type of setting, comprising 18 retorts, only requires a small amount of hydraulic power to operate the bottom mouthpieces. Moreover, it is a system in regard to which information covering residuals and wear and tear is available. The setting of 18 retorts is an undoubted advance on the previous setting, inasmuch as it enables the labour charges to be greatly reduced; and in cases where circumstances permit, the intermittent system undoubtedly lends itself to the arrangement of working with two eight-hour shifts in place of three. Although no installation of any size, comprising the new setting of 18 retorts, was to be found in exemplification of the low labour charges claimed for this latest development in the Dessau system, yet it was not difficult to arrive at an accurate estimate of its possibilities in this regard.

Another example of intermittent carbonization in vertical retorts—namely, Dempster's—appealed to the author as practically the Dessau system with certain minor alterations and improvements. The arrangements for operating the retort mouthpieces appeared decidedly ingenious, and the device for charging the retorts distinctly good from the point of view of reducing the smoke to a minimum and further simplifying the work of the men. The idea, however, to endeavour to charge in such a way that the larger lumps all accumulate at one side of the retort is doubtless based on the early experiences and theories in regard to the Dessau system when it was considered desirable to screen the coal and charge the fine and large separately. No doubt this plan is advantageous, though its application is probably regulated by the class of coal used, and the amount of crushing to which it is subjected; and it was a matter of special comment to find that such arrangements do not seem to have been found necessary in recent installations. The freer access the gas has from the charge, and conse-

quently the lower the pressure in the retort, the better should be the results obtained. Despite this pressure disability, however—if it can be so described—the results obtained by the Dessau system under the existing conditions are particularly good; and the author was unable to discover that the pressure in the retort was regarded as a real disadvantage by those who had installed the system.

Another modification introduced into the Dempster settings, which has also for its object the reduction of pressure in the retort, is a pipe connecting each pair of bottom mouthpieces. This idea, however, hardly appeals to the author as theoretically correct; and it is doubtful if it can be conveniently worked in practice.

Horizontals and "Heavy" Charges.

The greatly improved use of horizontal retorts is doubtless the outcome of the introduction of the Dessau vertical retort, with its full charge; and the author noted a large number of works where horizontals are being worked with "heavy" or "full" charges. But he found that by heavy charges was not necessarily meant a full retort; charges of 8 cwt. and 9 cwt. were often described as "heavy." The system of full charges appeared to be generally accepted as the best way to work horizontals; but there are only three types of charging machines available for such work—namely, the De Brouwer, the Arrol-Foulis, and Drakes. The cost of production being in these days of paramount importance, the De Brouwer and Drakes machines appealed as being more economical. But one must regard the Arrol-Foulis apparatus as less liable to uneven charging, because the element of uncertainty—inseparable from the human operator—does not affect the efficient working of this machine to such an extent as the others; and since the author holds the view that full charges are best worked with a small space left on the top of the charge, for this reason the Arrol-Foulis machines commend themselves. But the system requires three machine men per shift; and so, comparatively, it should not be able to reduce labour charges so low as with the other types of machines.

The ideal arrangement is probably the employment of a combined charger and discharger; but that ingenious machine, the Fiddes-Aldridge, has not yet reached a stage where a retort can be fully charged with it. Unless this is done, and the retorts charged every twelve hours, the author fails to see how horizontals can really hope to compete with the results obtained from verticals. The examples illustrating this development of working horizontals with full charges appealed to the writer as instances which particularly proved the resourcefulness of the British engineer in adapting existing plant to suit much improved working arrangements. Only two works were visited where installations of horizontal retorts were found deliberately designed for working with full charges. Unfortunately, the author was unable to see these in operation; but, as will be noticed later, he fails to see how any new horizontal installation can compete in regard to cost of production with an installation of vertical retorts worked in a strictly comparable manner.

Continuous Carbonization in Verticals.

Continuous carbonization in vertical retorts naturally engaged close and careful investigation. The author admits that he went home feeling—in agreement no doubt with the majority of gas engineers—that continuous carbonization was the ideal system of gas production; but he confesses that the completion of his investigations left him somewhat disappointed. This disappointment did not spring from the feeling that this desirable system of gas manufacture would not eventually become a success from many points of view, but rather that its development still left a good deal to be desired. The position he found it in suggested that though continuous carbonization appealed as being an ideal method of making gas, yet it was not necessarily an ideal method of obtaining the best all-round results. Rightly or wrongly, the author had pictured the system as a distinctly continuous process, not only in the evolution of gas, but in the supply of coal to the retort and the discharge of coke, but found that of the two examples which had come to the front—namely, the Glover-West and the Woodall-Duckham—the Woodall-Duckham was really the only one aiming at continuous working; and he was forced to thinking that the automatic coal-feed in the latter could be advantageously superseded by the pressure-feed system.

The particularly smooth working of the Glover-West installation at Manchester, its solid construction, and ingenious heating system, undoubtedly impress the observer. These outstanding features of the Glover-West process, and the realization of the immense amount of work and ingenuity put into the development of the Woodall-Duckham system, together with the fact that both of them work with complete absence of smoke and produce coke practically cold, did not fail to elicit the admiration of one who had been absent from the fields of active development of the gas industry for a number of years, and to foster the wish that such perseverance and endeavours on the part of British engineers should be crowned with great and lasting success. But, notwithstanding this, it was apparent that the possibilities of both systems had at the moment to be judged mainly on opinion, theory, and surmise, rather than on the practical working of an installation over any length of time.

The Glasgow Verticals.

The system of vertical retorts developed by the President of the Institution—Mr. Alex. Wilson—at Glasgow suggested a happy medium between continuous carbonization and the intermittent system, and had in consequence received the name of "continuous intermittent." The writer prefers to refer to it as continuous carbonization on a "positive" system. His regret was that the one example working was not past its experimental stages; but he could not help forming a high opinion of its future possibilities. The system had yet to demonstrate that it could economically deal with any class of coal; but the work it was designed specially to do—namely, to improve the coke from Scotch coals—was certainly being performed in a commendably satisfactory manner. Its distinctive feature is the obviating of any risk in regard to the possibility of the coal "hanging" and not sliding down the retort; provision being made to ensure the upper portion of the charge following the coke when the latter is drawn off, so that there is a free open space at the top of the retort to receive the charge of fresh coal. Another important feature is the absence of constantly working machinery.

Carbonization in Bulk.

It is improbable that any one will deny that the development in regard to carbonization in bulk, and the adoption of chamber-ovens for gas-works purposes, has been one of the striking features of the advances in the gas industry on the Continent during the past few years. Despite the full and descriptive articles which have appeared in the Technical Press from time to time, and the highly interesting paper read by Dr. Rudolf Lessing at the Institution's annual meeting in 1909, the author admits that he was hardly prepared to find, as he did in many works, the erection of such large elaborate installations as exemplified by the inclined chambers for the manufacture of gas. Without in any way wishing to appear unduly critical of this system, he is forced to describe many of these installations as colossal; and he is doubtful if such a system can be economically adopted in British gas-works.

Carbonization in bulk has appealed to many as offering a cheap method of gas production; but the practical application of chamber-ovens for gas-works purposes appears to develop two serious difficulties: Firstly, the difficulty of keeping the gas of a uniform quality when the ovens are worked in the most economical way—*i.e.*, carrying out all the work of carbonization during the morning shift; and, secondly, the handling of the huge mass of hot coke resulting from the charge. The latter evidently necessitates the provision of a very special and expensive plant, and is a difficulty probably not yet satisfactorily solved. It is claimed that the economy obtained from the adoption of these inclined chambers is the low cost of labour for operating. But this is brought about by carrying out all the charging and discharging operations in the morning shift; and consequently from early in the afternoon until early the following morning no fresh coal is being put into the ovens. Under these conditions, it is difficult to see how gas of uniform quality can be distributed over the twenty-four hours; a deduction which was supported by particulars the writer obtained.

The question of carbonization in bulk for gas-works should not be confused in any way with the utilization of surplus gas from coke-ovens for distribution by a gas undertaking, which the author regards as quite a different propo-

sition, and which he does not propose to touch upon in this paper.

Points Regarding Selection.

Owing to these epoch-making changes and developments, there are many points which have to be taken into careful consideration in selecting a system of carbonization; and the difficulty in arriving at a conclusion has never been greater than it is at the present day. The difficulty is not, perhaps, that there are several good systems to choose from, but rather that rapid developments may prove that what appears a good selection to-day will be superseded in a very short time. And yet it is hard to imagine, despite the progress of the age, and the improvements and advances made during the last eight years, that in the future it can be more difficult and, since labour charges can now be reduced so very low it would appear that further advances must be in the direction of improved carbonizing results.

Local circumstances must, of course, be the leading consideration to guide one in the choice; and there is only one point about this argument which is general to all gas undertakings—the necessity to manufacture the product at the lowest possible cost and with the greatest efficiency. Local conditions may be stated to cover chiefly the cost and conditions of labour, the class of coal to be carbonized, the quality of coke required for local consumption, and the illuminating power of the gas to be supplied. Everywhere, of course, the labour question is a highly important one; and particularly is this so in Australia, though it must not be thought that wages and capital cost are out of proportion, or, in other words, that the high labour charges make it more profitable to adopt the greatest labour-saving appliances. As a matter of fact, the arguments are much the same as at home; for although wages are higher to the extent of about 75 per cent. than, for instance, those paid in London, plant costs 60 to 80 per cent. more than it does at home.

The quality and characteristics of the coal available for carbonization are probably the predominating factors. The coal now being generally used for gas-mak ng purposes in Victoria is very different from that in use a few years ago; and in a comparatively short time all gas undertakings will have to draw their coal supplies from the Maitland coal fields in New South Wales. This coal is highly bituminous and is probably the richest gas coal yet found, but while giving a good make of gas of high illuminating and calorific value, yields, carbonized in the ordinary way, a decidedly small coke. It has, however, been proved ["Journal of Gas Lighting," Feb. 15] that with heavy charges in horizontal retorts this coal can be made to yield a coke of much improved quality. This point is of the highest importance, because the coal regularly carbonized in Melbourne for a long time past yields a large coke, to which the market has, of course, been accustomed. When, moreover, there is a local demand for coke for trade and manufacturing purposes, a large and fairly hard coke is desirable. This being the case, care must be taken that a new system of carbonization will neither make the coke too hard and dense or too soft and spongy. There is the fear that with the new carbonization systems where the coal is at rest for a time, certain coals may produce a coke so dense and hard as to be unsuitable for what household business exists in the district.

Having regard to local conditions, the points which the author, therefore, had to take into close review in considering all the new systems were: Results, fuel account, conditions of working, area occupied by settings, wear and tear, labour charges, and capital cost.

Results.

The author was not helped in his investigations by any comparative figures of trials of the various new systems. This was particularly the case with the verticals, in regard to which there appeared to be an absence of working results obtained over an appreciable length of time, which offered, in any way, a close comparison of the possibilities of the plants. Among the vertical systems, the Dessau was found to be of the greatest advantage, and large makes of gas per ton were reported from all undertakings visited which have adopted it. These results are no doubt to a great extent due to the use of steam, which in many Continental works is freely employed so long as the gas is maintained at a calorific value of about 5000 calories per cubic metre; entire disregard being had to the question of illuminating power. It is no doubt due to this fact that the misconception arose that gas of a candle power suitable for British conditions could not be manufactured in the Dessau vertical retort. The working at Sunderland appears to have entirely disproved this suggestion, and one could not fail to be impressed by the results obtained by the Sunderland installation after being in constant work for twelve months, and using some of the most difficult coals in the Durham district.

Very large makes per ton are also experienced with the chamber-ovens, while it is well known that horizontals with full charges have been the means of largely increasing the yield of gas. The writer abstains from quoting any particular figures in regard to this item, because of the different classes of coal carbonized at various places. He may, however, record that the average make from the installations of Dessau verticals visited was 12,920 cubic feet, with a calorific value of 577 B.Th.U. gross; from the installations of chamber ovens visited, 12,128 cubic feet, with a calorific value of 567 B.Th.U. gross; while the average of the yields produced at works visited where heavy charging in horizontals had been adopted was 12,188 cubic feet, the calorific value being 520 B.Th.U. net. These particulars are interesting; but local conditions and the different classes of coal used detract largely from their value for comparative purposes.

It was also found that considerable increase in the yield per ton was among the claims of continuous carbonization. But, as intimated, the results from an installation of this type spread over any length of time were not found to be available.

Vertical Systems and Australian Coal.

In considering the possibilities of the two vertical systems, the author inclines to the theory that from the same coal the intermittent process should give a somewhat higher sperm value than the continuous system, because in the latter form of plant there must be a tendency for a certain portion of the illuminating hydrocarbons to be decomposed owing to their meeting with the hot coke and the walls of the retort on their way up through the charge. To assist him in arriving at a conclusion as to the plant to be selected, the writer had available a small quantity of Australian (Maitland) coal for trial in the various vertical systems. For permission to carry out these tests, he is greatly indebted to the engineers of the undertakings who kindly facilitated the work. As, however, the quantity of coal for each test was very limited, it will be recognized that a trial extending over a comparatively few hours cannot well do justice to any plant; and it is not considered desirable therefore to publish the results. Neither would it be fair to draw a definite conclusion as to the comparative sperm values obtainable from the various plants. But it may be mentioned that, after taking into careful consideration the circumstances of all the tests, there was indication that support of the theory already alluded to may be looked for in constant working. But, as suggested, the author does not consider the evidence conclusive on the point; and he regards it as a matter requiring further investigation. He is able to say, however, that in the three systems so tested—viz., the Dessau, Woodall-Duckham, and Glover-West—the results obtained in all three cases were superior to those resulting from carbonization of the same coal in horizontals with full charges. They indicated that gas of an illuminating power to satisfactorily comply with the Melbourne standard could be obtained with the coal tested—namely, 15-candle power gas tested in a 15-hole argand burner with a 7-inch chimney.

Quality of the Coke.—In the carbonization developments, the question of the quality of the coke produced in various systems is one which has come very much to the front, and has been largely debated. The general experience of working horizontal retorts with full charges is that the coke has been greatly improved, becoming denser, larger, and harder; while as the outcome of this experience, the use of cheaper and inferior coals has, in some works, become possible. As suggested, the question of the quality of the coke produced is mainly a matter of local conditions, regard being had generally to what the local market requires and has been accustomed to.

As stated, for many years, the coke supplied from the Melbourne Gas-Works has been large in character—being produced from coal from the Newcastle (New South Wales) mines, which readily cakes during carbonization. It has already been mentioned that the new coal from the Maitland field (from the same State) naturally only makes a small coke. In turning to the consideration of verticals, this point then had to be carefully borne in mind; and experi-

ence has already shown that the Maitland coal worked in heavy charges produces a larger coke than when carbonized in light charges. The author, therefore, formed the opinion that in vertical retorts the coke produced from this coal should be considerably improved so long as the coal was maintained at rest during carbonization. The quality of the coke produced by continuous carbonization was a question, however, which had to be answered as the result of a practical test. The writer is able to say here that the tests carried out indicated a confirmation of this opinion—coke fairly hard and bright and chiefly large, with a low proportion of small, being produced from the Dessau verticals.

The coke produced from the two continous processes was, however, though bright, not so large or hard as that from the intermittent retorts, and was also much lighter; but the coke from the Woodall-Duckham plant contained more large than that from the Glover-West—the latter producing a small coke. At first the explanation of this was not quite apparent; but the author is of the opinion that the result is due to the superior type of coke-extractor in the Woodall-Duckham plant, which appears to allow the coke to pass from the retort in much larger pieces. Here it may be remarked that it will be interesting to learn how this lighter coke behaves in a screening plant. It must not be omitted, also, to refer to the production of dry coke in the continuous process. The author, however, fails to fully appreciate the advantages of this, for where the coke supplied by an undertaking has regularly contained a certain amount of moisture, the expediency of commencing to supply a dry coke in its place appears to be an open question.

Permission was also kindly granted to carry out a coking test in Mr. Wilson's retorts at Glasgow. The result was the production of a coke of good quality, fairly hard, and containing a fair percentage of large. No doubt the fact that in this system the coal is only disturbed every four hours during its passage through the retort, has an important bearing on the quality of coke produced.

Fluid Residuals.—In regard to the yield of the two fluid residuals, all the evidence gathered respecting the Dessau process on the Continent indicated that the yield of both tar and ammonia had increased, and the former improved in quality. Generally the yield of ammonia appears to have increased about 20 per cent. But the author was especially impressed with the fact that, as the result of considerable work at Sunderland, a notable increase in the yield of tar and ammonia compared with horizontals had been experienced. This is a point on which full particulars are required regarding the continuous process, and although it is claimed that similar increases result from carbonization of coal in these systems, yet the author was unable to find figures of actual results spread over any length of time. It is interesting to remark here that he also failed to find, at any gas-works visited where full charges in horizontals had been adopted, evidence that the yields of tar and ammonia had increased (as compared with light charges) to anything like the result obtained from the Dessau system. The quality of the tar was generally reported to have improved; but the experience as to yield was apparently by no means uniform—in fact, an increase in the yield of ammonia seems much more general than an increase in the yield of tar. In regard to chamber-ovens, the author was informed that the general experience has been to increase the yield of ammonia by 25 per cent.

Two advantages claimed for the intermittent vertical system are: The absence of naphthalene in the gas produced, and the reduction in sulphur compounds, by, at least, one-half, compared with the gas produced in horizontal retorts from the same coal. The author considers that these points have been firmly established by the results obtained at Sunderland by Mr. C. Dru Drury, to whom he is much indebted for the full information supplied regarding the working of his installation. The author at present sees no reason why similar results should not be obtained by continuous carbonization; and as he holds a strong opinion that the gas supply to-day should be of constant quality, and as pure as possible, he considers that the vertical retort offers to the industry the best form of carbonization yet known, and one by which all thought of purification by lime may be finally abolished.

Fuel Account.

The advance recorded in the system of heating retorts is unquestionably the ingenious arrangement introduced into the Glover-West continuous plant. The complete control of the heating of the setting thus brought about, and the extraction of heat from the coke by the secondary air, point to the Glover-West system of continuous carbonization proving the lowest of all for fuel account. The test, of course, is the amount of coke made for sale; and in due course, no doubt, comparative figures will be forthcoming as to this.

Conditions of Working.

The unquestionable advantage of the continuous process is that the operations are carried on under smokeless, and, consequently, very much improved, conditions—in fact, it is almost difficult to believe that the plants are carbonizing units. On the other hand, with the intermittent system, either with retorts or chambers, there is a certain amount of smoke, and steam also, when the coke is quenched; but in the case of the former system, this is materially reduced in quantity as compared with the working of horizontal retorts. In view, however, of the surrounding conditions under which many gas-works are carrying on operations, it is probably a question much of sentiment as to whether the smoke produced in the intermittent system is an objectionable feature of it, though doubtless an improved method of quenching or cooling the coke would be distinctly advantageous. Still, no one will deny that smokeless conditions are ideal, and that it is a commendable characteristic of the continuous process.

Wear and Tear.

One of the points which suggested considerable advantage to vertical retorts is the cost of maintenance and wear and tear. This is particularly exemplified in the case of the Dessau system; and wherever these verticals had been installed, it was found to be the opinion that they would cost less to maintain than either horizontal or inclined retorts. In Berlin, the author found this opinion thoroughly supported by the experience of Herr E. Korting; and he is also indebted to Herr Prenger, the Chief Engineer of the Cologne gas undertaking, for the information that the cost of repairs to the Dessau system was only working out, in his case, at about one-third of the cost of repairing horizontals. The continuous systems have not, of course, been long enough in constant action to supply any definite figures on this head, and all the new installations will need to run several years longer before an absolutely final determination can be arrived at. But the nature of the design and construction of vertical retort-settings undoubtedly suggests that low maintenance must prove to be one of their leading advantages.

Although the cost of maintenance of vertical retorts is likely to be much less than with horizontals, the author is not of opinion that the new carbonizing chambers will prove themselves to such advantage. On the contrary, he considers it likely that, from their size and necessary design, they may prove expensive plant to maintain.

Area Occupied by Various Systems.

The Woodall-Duckham system occupies less ground area than any other; and it was found that a setting of each type of the vertical systems required area as follows:—

System.	Area Occupied by One Setting.
	Square Feet.
Dessau (setting of 18 retorts 4-metre or 5-metre)	324
Woodall-Duckham	248
Glover-West	355

Of course, the area occupied by a carbonizing unit comprising any of the new systems is governed mainly by local circumstances and the desires of the engineer; but it may be taken that plants of a capacity of 250 tons per day would occupy minimum ground area as follows:—

System.	Area.
	Square Feet.
Dessau, 4-metre	11,390
,, 5-metre	9,128
Woodall-Duckham	9,162
Glover-West	10,520
Inclined chambers—Munich	12,521
Horizontal ovens—Koppers	25,039
Horizontals	12,478

The large area required by an installation of horizontal ovens is explained by the producer-gas plant being made a separate portion of the installation, and also by the provi-

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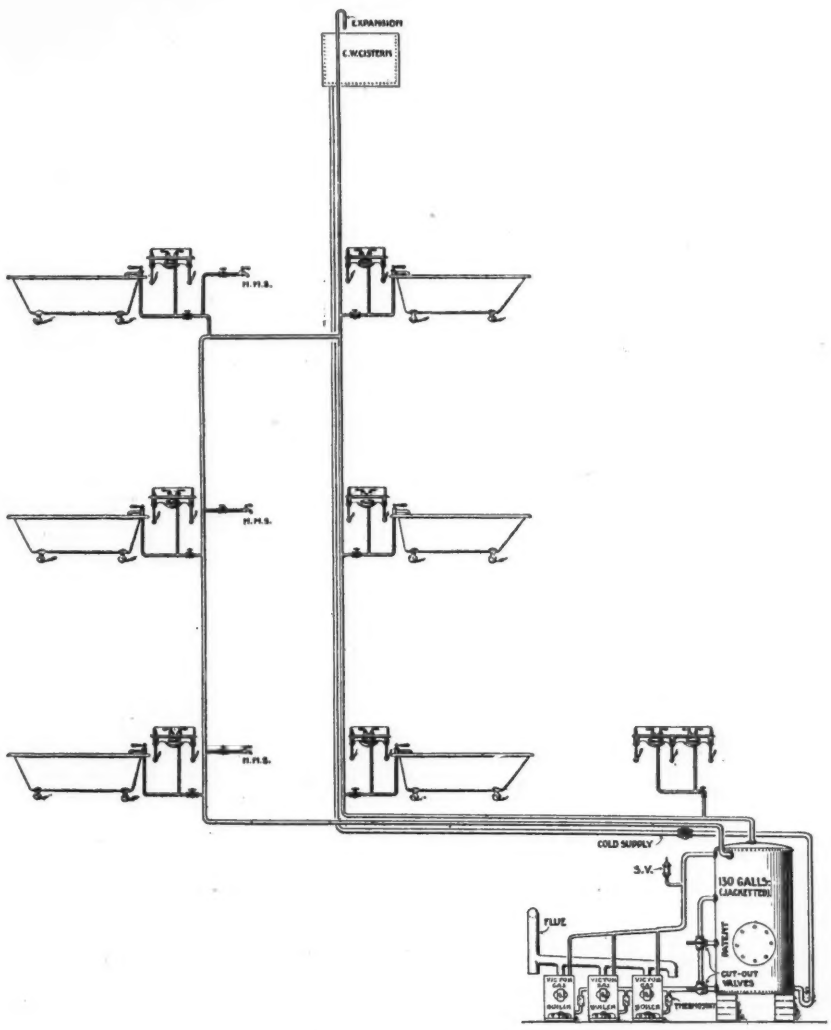

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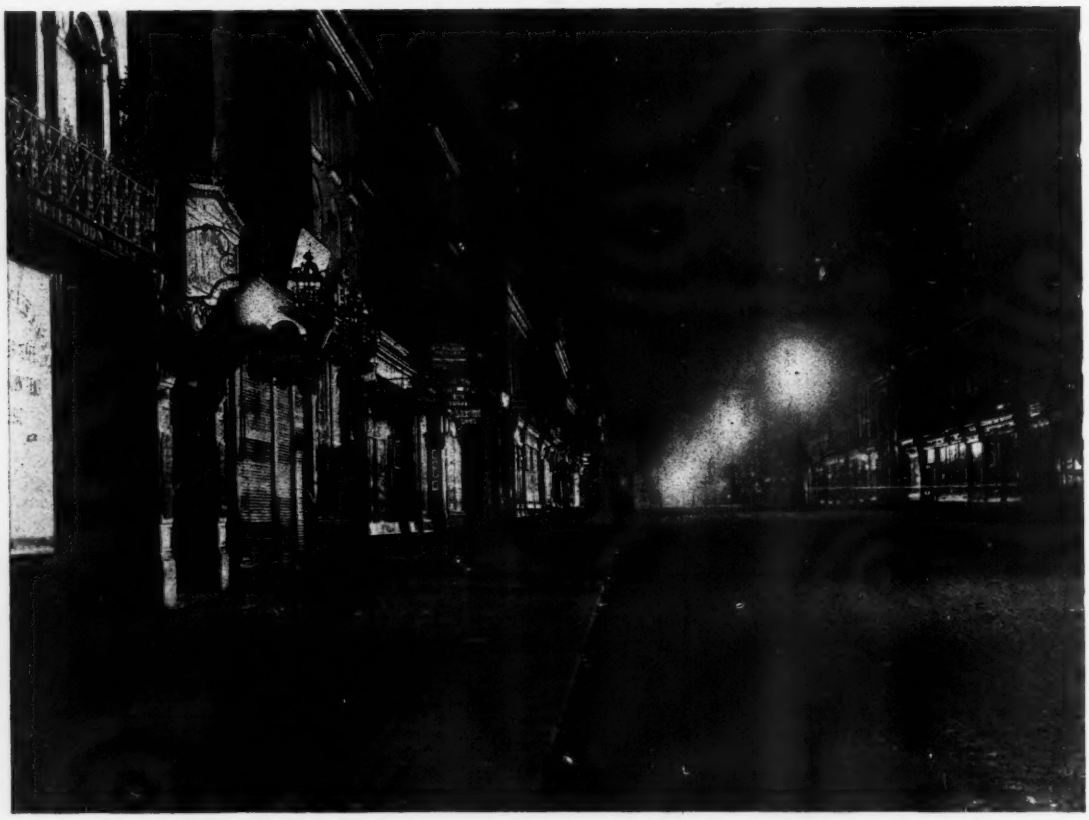

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sion of wide stages on both sides of the ovens—one for the charging and discharging machines, the other as a platform for coke.

Labour Charges and Capital Cost.

Inquiries into the important question of labour charges resulted, in so far as the vertical systems are concerned, rather unexpectedly. It was found that the continuous system, in its present state of development, offered no cheaper cost of manufacture than the intermittent system. The writer arrived at the following approximate figures of the duty per man per eight hours on installations of similar capacity, expressed in tons of coal carbonized :—

System.	Tons of Coal Carbonized per Man Employed.
Dessau, 4-metre	23—29*
,, 5-metre	30—36*
Woodall-Duckham	20
Glover-West	22
Inclined chambers, Munich	31—22†
Horizontal ovens, Koppers	28—22†
Horizontals	10—18*

* According to whether three or two shifts are worked per twenty-four hours.
† ,, ,, ,, one or two ,, ,, ,, ,, ,, ,,

In explanation of this table, it must be stated that the figures are compiled from the assumed necessary labour on installations capable of carbonizing 250 tons of coal per day, based on experience to date, and cover all labour for the supervision of the retorts, the attendance on coke-conveyor or telpher-plant, firemen, supplying coke to generators, and incidental work in the way of attention to hydraulic mains, &c. They do not include foremen, the attendance at coal crushers, elevators, and conveyors, or scurfing, which are common to all systems. The author's opinion is that this is the only reasonable way to compare the labour charges on different plants, since it eliminates from the question the disturbing factors of varying wages and makes per ton.

In the case of the vertical systems, the writer did not find any installation of the capacity referred to to guide him closely in arriving at the duty to be expected per man employed. As a matter of fact, however, he found a duty of 20 tons per man being realized with the installations at Mariendorf, where the retorts are 5 metres long in settings of twelve. Moreover, only two shifts are worked, and the men are actually employed about six hours each shift. In the above table, the contemplated Dessau installation covers the employment of the new setting of 18 retorts. There is no question that this setting, wherein the bottom mouthpieces of three retorts are coupled together and so operate as one, has greatly reduced the labour charges; and it is not difficult, having regard to the "positive" character of the work to be performed in operating an installation of intermittently worked retorts, to arrive at a fair estimate of the labour necessary to be employed.

In the special example under consideration, 270 retorts, 4 metres long, would be installed; and assuming the duration of the charge to be twelve hours, this would mean that in a shift of eight hours 180 charges would need attention, equivalent to 22½ per hour. As, however, three retorts are connected together, the real number of charges is one-third of 22½ or 7½. Even if it is presumed that the draw will last the extraordinary period of twenty minutes, it will be readily seen that there is ample time for the men to attend also to the necessary cleaning-up and give attention to the hydraulic mains. The employment of only two shifts of men reduces labour charges considerably; and this plan of working is particularly applicable to vertical retorts on the intermittent system. With an installation of large capacity (say, at least 300 tons per day), and retorts 5 metres in length installed, the writer ventures the opinion, as the result of his observation on many installations, that it should not be difficult to realize a duty of 36 to 40 tons per day per man on the basis stated. Incidentally, he sees no reason why, on the intermittent system, each pair of retorts in the settings of 6, 8, 10, or 12 should not be coupled together and worked similarly to the beds of eighteens.

The figures relating to the continuous process are based on assumption rather than on actual practice, since no installation exists approaching the size contemplated. It is certainly strange that the cost of continuous carbonization is apparently more, rather than less, than the intermittent; but the explanation of this appears to lie in the fact that the former systems, as worked at present, require considerably more attention than the intermittent retorts.

It will be noticed that the duty per man employed on the installation of Munich inclined chambers stands at a high figure when the carbonizing operations are confined to one shift. Moreover, such a duty as stated is being realized in daily work in Germany. If the ovens are to be worked with two shifts, the duty is reduced from about 31 tons to about 22 tons per man, which, it will be noticed, is only about equal to the lowest result to be anticipated from an installation of vertical retorts.

The duty suggested for a horizontal installation requires fuller explanation. It does not appear that any existing installations are worked with the mean economy contemplated in the table. With the largest installations, a duty of 10 to 11 tons per man is not exceeded, and in some cases is far from reached. The writer considers that verticals can only be properly compared with an installation of horizontals designed in accordance with the experience gained during the last few years—in fact, on the lines of those fine installations at Burton-on-Trent and Sheffield, which he was fortunate enough to see through the courtesy of Mr. J. Ferguson Bell and Mr. J. W. Morrison, and which are perhaps the leading examples of horizontal retorts erected especially for working with heavy charges.

The author has already expressed the opinion* that the section of retorts employed for a long time must now be superseded—at any rate, for a large gas-works. With a larger section, and longer length, the horizontal retort becomes a much improved carbonizer; and he considers that to obtain the best results it should be of such a size as to permit a minimum duty of 36 cwt. per 24 hours. In arriving at the figure shown in the above table, the author has, therefore, assumed this duty, which would necessitate the employment of 140 retorts, or (say) fourteen beds of tens, to carbonize 250 tons per day working twelve-hour charges. These retorts might be worked with either De Brouwer or Arrol-Foulis machines, or a one-man machine of the Fiddes-Aldridge type. Although, as already mentioned, the last-named machine has not yet demonstrated its ability to fill a retort full, the system may be allowed to stand as representing one whereby the minimum amount of labour would be required to operate the plant.

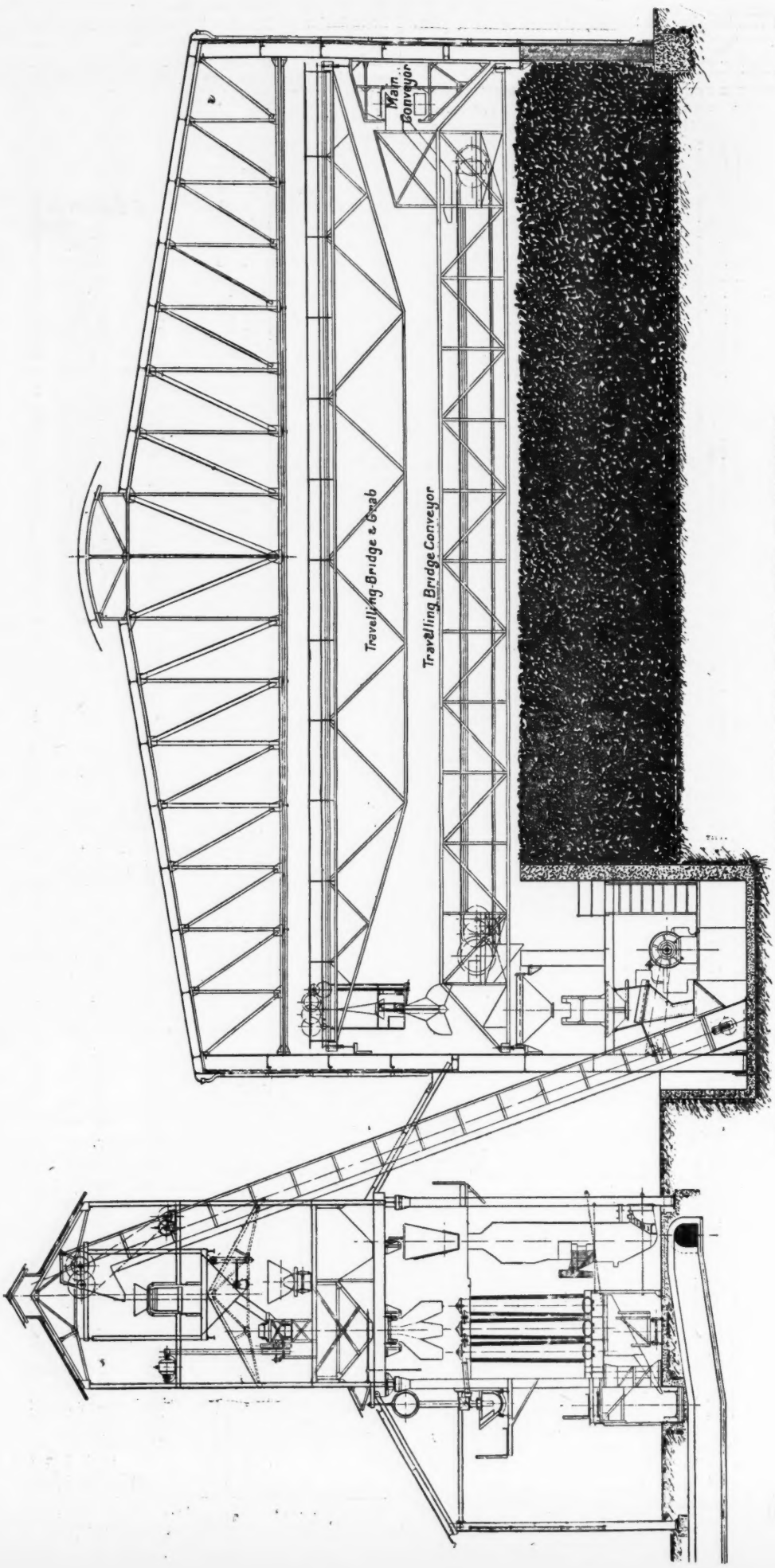
Under these conditions, the author considers the minimum amount of labour employed per 24 hours, working three eight-hour shifts on the installation, would be 24, 27, and 21 respectively, including all retort-house labour (excepting foremen, coal crushers, and elevators), and attendance on coke conveyor and power plant. As an installation of Dessau verticals of similar capacity should only require at the most some nine or ten men per 24 hours, it is fair to say that the horizontals require the employment of at least twelve men more, even under the best theoretical conditions. Of course, the men employed on the horizontals would probably suffice to work a somewhat larger installation; but this also applies to the staff that is required by the Dessau retorts.

Working with two shifts per 24 hours is rather more favourable to the horizontals than to the intermittently worked verticals, always presuming that a machine of the type of the Fiddes-Aldridge is available. This plan of working the retort-house is decidedly convenient and economical, though the author does not quite see how it is to be applied to verticals worked on the continuous principle.

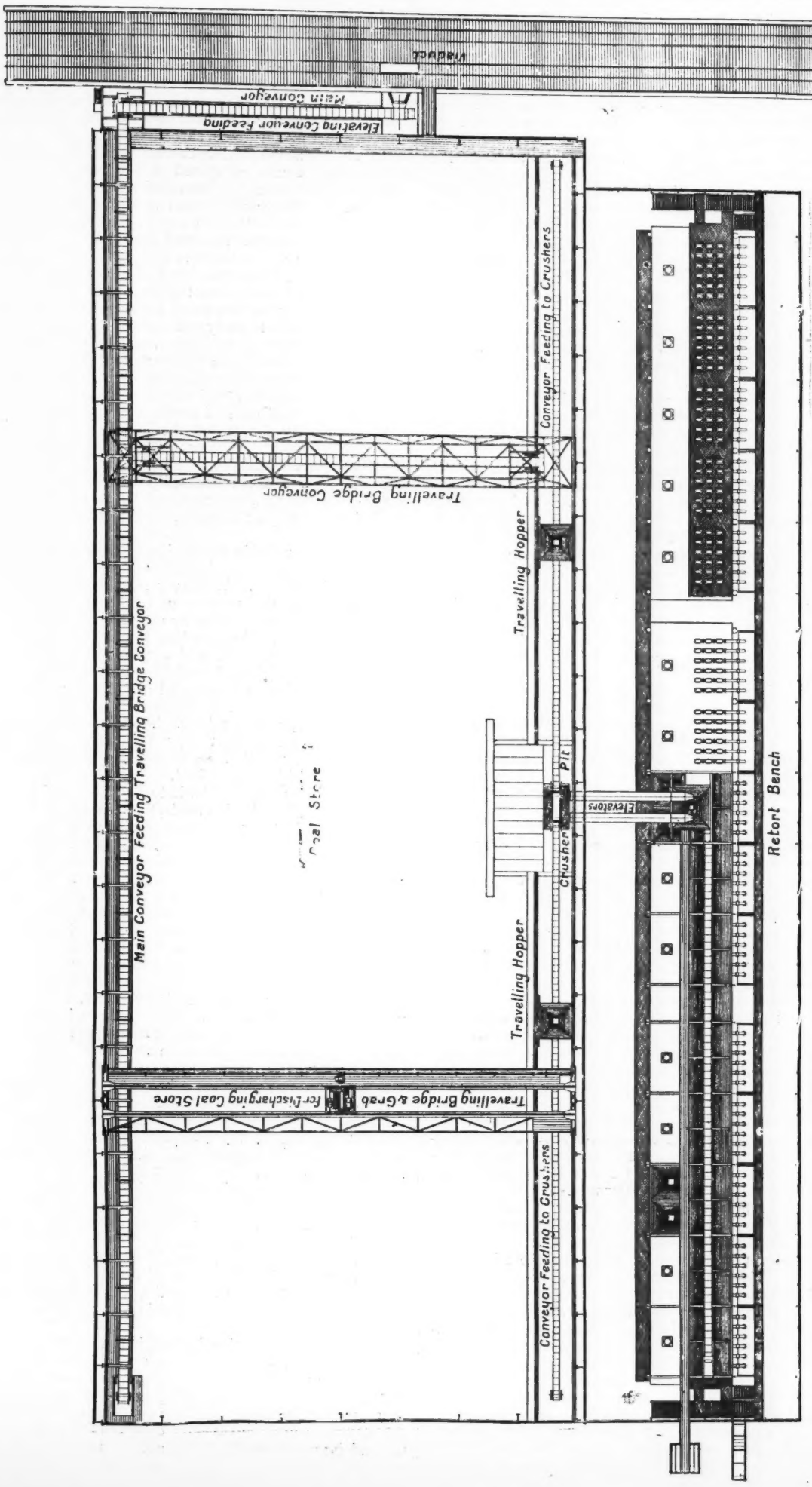
Capital Cost.

The question of capital cost is naturally one of great importance; and it is probable the present large capital outlay necessitated by some of the new systems renders their adoption prohibitive to many gas undertakings. The author found that all the new systems involve a greater capital outlay than horizontals. Particularly is this so in regard to the chamber settings, the extensive construction of which naturally reflects on the item of capital cost. It was estimated that an installation of Munich inclined chambers would cost at home nearly £30,000, and in Melbourne nearly £40,000, more than an installation of verticals. This additional expenditure would only effect a saving of two men per 24 hours, which would be entirely lost if the chambers were worked similarly to verticals—*i.e.*, by two shifts—in order to steady the illuminating power of the gas produced. He fails to see, therefore, how these installations can justify themselves, as, at their present cost, the capital outlay appears to be out of proportion to the advantages gained.

* Address to the Victorian Gas Managers' Association in November, 1909—see "JOURNAL" for Feb. 15, 1910, p. 423.



SECTION OF THE DESSAU VERTICAL-RETORT INSTALLATION AND COAL-STORE AT MELBOURNE.



PLAN OF THE DESSAU VERTICAL-RETORT INSTALLATION AND COAL-STORE AT MELBOURNE.

There is no doubt, however, that the introduction of these chamber settings has wrought a wonderful alteration in the amount of labour required on a gas-works. The magnificent new works recently erected at Moosach, Munich, to the designs of the engineer, Herr Ries, are a great exemplification of the saving in labour effected; for when the station is manufacturing 3 million cubic feet of gas per day, there are only five men in all employed on the works during the night shift. No one will deny that this is a noteworthy achievement.

Recent developments with horizontals and the increased duty of the retort have necessarily materially decreased the cost per ton-day capacity for which an installation can now be erected. The writer is of the opinion, however, that an installation, on the lines referred to in an earlier paragraph could probably be erected at home for about £100 per ton, including retort-house, all coal plant, stoking machines, and hot-coke conveyor. In round figures, therefore, the total capital cost of such an installation of horizontals would be approximately £10,000 less than one of verticals. The latter, however, would reduce the labour charges by at least twelve men per 24 hours.

Again, assuming home conditions, and estimating these men at 6s. per shift, and adopting the multiple of 250, the saving in wages due to the verticals may be put down at £900 per annum. To make the comparison complete, it is necessary to add to this sum an allowance for maintenance and wear and tear on the stoking machines and the power plant necessitated by the horizontals. The machines, together with power plant in duplicate, and house for the latter, would probably cost not less than £3100. On this sum it would not be fair to allow less than 12½ per cent. so that £387 must be added to the extra cost of wages on the horizontal installation. Thus a total annual saving by the adoption of the vertical installation is £1287, representing 12·87 per cent. on the additional capital outlay. It thus appears a fair conclusion that verticals justified themselves on financial grounds—an argument which applies similarly to Melbourne conditions.

Final Selection.

From the foregoing it will be realized that the author had little difficulty in arriving at the determination that a system of carbonization in bulk would not be a suitable one to adopt. The two main reasons for the rejection of horizontal ovens was the large amount of area occupied by such an installation, and that the labour charges entailed by them were higher than with the vertical system. It was evident, too, that the Munich inclined chambers could not be selected for the reason that the high capital cost involved did not appear to be justified by the results obtained.

In finally considering the question of continuous carbonization, the author was compelled to decide against the Woodall-Duckham plant on the chief points (*a*) that the system in its latest development had not experienced any trial, and (*b*) existing installations all indicated that the cost of manufacture by the plant would not be so low as with the intermittent system in vertical retorts.

The Glover-West plant was decided against because it was considered that coke of a satisfactory character for the local market could not be produced in it with the coal to be carbonized; that it was considerably more expensive from the point of view of capital outlay than an installation of intermittent verticals; and that, beyond trial tests, no particulars were forthcoming as to yield of fluid residuals.

The Dessau system of intermittent carbonization in vertical retorts was adopted in preference to continuous carbonization, because: Firstly, the author felt that there was reason to believe that with the intermittent system a rather higher sperm value can be obtained from the same coal; secondly, it offered a means of considerably improving the coke from the particular coal to be carbonized, and unquestionably made a more suitable coke for the Melbourne market than the continuous process; thirdly, the existing examples indicated that gas can be manufactured much cheaper on a large scale by means of the intermittently worked retort in settings of eighteen than by the vertical retort worked continuously. A further point in favour of the intermittent system is the complete absence of machinery. The continuous system requires power to operate it; and machinery, though of a simple and slow-moving type, must be installed and run continuously in order to keep the process going. Compared with this, an intermittent installation only requires, as already stated, a small amount of hydraulic power to operate the bottom mouthpieces when discharging, which can be supplied in a simple fashion. Moreover, this does not affect the process of carbonization; but a stoppage or breakdown of machinery in connection with continuously worked retorts would be a very serious matter. In the face of these advantages of the intermittent system, the author did not feel justified at the present junction in adopting smokeless carbonization.

In arriving at the final determination, the Dessau vertical retort was, of course, compared closely with the horizontal. But the writer came to the conclusion that, with the present knowledge of the possibilities of the latter, it could not be economically adopted for, at any rate, a large installation. It seemed evident that the extra capital cost of an installation of Dessau vertical retorts was justified by the saving in labour alone, without taking into account the increased value of fluid residuals, and the improved character of the coke. Moreover, he was much impressed with the advantage of being able to carry out carbonizing operations with the entire absence of machinery, which, on a large works, must tell considerably on the important item of standing charges, since a works manufacturing entirely by means of intermittent verticals would necessarily mean the employment of a reduced staff of mechanics and fitters. It has also been clearly shown that the Dessau system produces less naphthalene, and, at the same time, reduces the sulphur compounds considerably; and while the horizontal retort with full charges has undoubtedly increased the yield per ton to something perhaps approaching that from verticals, yet it does not appear to have affected these two important questions.

There is one point in connection with the Dessau system which has not been particularly alluded to—namely, the question of steaming. Whatever may be the correct economic aspect of the question as to whether water gas is better made in the retort or by means of a separate plant, the author cannot help regarding the Dessau arrangement as especially convenient, and certainly advantageous in dealing with the rich coal available in Melbourne.

The installation to be erected at the West Melbourne Gas-Works will consist of fifteen beds of eighteen Dessau vertical retorts, 4 metres long. The illustrations show, in plan and cross section, the general arrangement of the new retort-house, with the coal-store adjoining, fitted with mechanical coal-handling plant.

The author would not like it to be concluded from the foregoing, and the selection made, that he regards the Dessau system as the last word in carbonization practice. He was in the position of one who, at a critical period in the history of the development of gas manufacturing plant, of necessity had to dip into the carbonizing "melting pot" and has, for the moment at any rate, taken out the Dessau system. He certainly looks to the further improvement of the continuous process; for its conditions of working are undoubtedly ideal. There are, of course, points about it which require the test of time to prove them, and doubtless more will be heard of the system of brick construction lately introduced into the Woodall-Duckham plant. It is surmised, however, that unless the coal carbonized is of a particularly good caking quality, the continuous process, in its present form, will not be able to produce a coke large or hard enough for trade purposes in many manufacturing districts. Possibly the future will see this objection overcome; and his conclusions are that, in the majority of cases, the selection of a new carbonizing system will be made rather with regard to the class of coke that it will produce from the coal used, than on the question of complete absence of smoke during carbonizing operations.

In cases where the coke produced by the continuous process is considered unsuited to the local conditions, and it is desirable to adopt smokeless carbonization, the author is inclined at the moment to look to a system as exemplified by Mr. Wilson's verticals, provided that the latter prove their suitability for all classes of coal. Incidentally, the author suggests that the slower the coal is passed through a continuously worked retort, the harder and larger will be the coke produced.

So far as carbonization in bulk is concerned, he sees in the present situation little chance of the chamber ovens competing satisfactorily with verticals, and the future will doubtless witness the large adoption of the vertical retort in some form or other and the gradual abandonment of the well-tried horizontal. Not only will its supremacy be assured by reason of its being able to reduce the cost of

production very materially, but also because, the author believes, it will prove considerably less costly for maintenance. Moreover, there is the important point in regard to the cost of manufacture which must not be overlooked in comparing the two systems—namely, that with an installation of verticals the cost per 1000 cubic feet should be practically the same all the year round—a point which cannot be claimed for an installation of horizontal retorts worked by stoking machinery. And with the coming of the vertical, with its greatly improved working conditions, the author foresees the gradual disappearance of the stoker from the retort-house and the employment of the more technically trained "carbonizer."

Referring, further, to the present general position of carbonization, the author ventures to point out that there appear to be two highly important matters which in the interests of scientific gas manufacture require most careful investigation. In the first place, it has been suggested that a higher sperm value and calorific multiple from the same coal may be obtained from the intermittent system. This point it would surely be advantageous to clear up soon; and he suggests that the Institution Carbonization Committee should pursue their endeavours to carry out comparative tests on various plants, such trials to extend over some time and to comprise two on each class of plant—one being with a coal of good caking nature and the other with one which does not cake well under ordinary carbonizing conditions.

The second point has reference to the length of retort employed with the intermittent process. The writer gathered that the adoption of the 5-metre retort was made possible by reason of the fact that on the Continent illuminating power was not a matter of consideration, and trials which had been carried out with the same coal in 4 and 5 metre retorts had shown that the candle power of the gas produced in the larger retort was some 2 candles lower than that made in the 4-metre retort. This result does not appear very easy to explain; and in view of the fact that the longer retort offers considerable economy in cost of manufacture, this is another point submitted as worthy of still further investigation.

Discussion.

The PRESIDENT, in inviting discussion on the four papers, called attention to the fact that Mr. Holmes Hunt's paper was the first they had had from a member residing in our dominions beyond the seas; and he hoped it would be followed by many more. As the time at the disposal of the members was rather limited, he hoped the speakers would be as brief and concise as possible.

Mr. EDWARD ALLEN (Liverpool) said, with the object of carrying out the request of the President to speak as shortly as possible, he had made a few notes, and, with the permission of the members, would like to use them. The retort-house still continued to be a special place of interest in gas-works. The papers on carbonization formed the important feature of this meeting. Many engineers had postponed renewals or extensions so as to have the assistance and enlightenment expected to be given by these papers; and there were others, whose choice had to be made during recent years, who had been anxiously waiting to see whether or not they had chosen wisely or otherwise. They were greatly indebted to the authors for their labours, and for the facts and opinions with which they had favoured the members. He hoped, however, that they would not be considered ungrateful, if, like Oliver Twist, they asked for more—more facts, more figures—so that they might be able to form their own opinions. Referring to the authors of three of the papers, it appeared to him that the first paper had been marked by carefulness, the second by candour, and the third by enthusiasm. The description and advantages of each system were fully given in the papers on the three systems, and were summed up with great ability by Mr. Holmes Hunt in the fourth. They were much indebted to him for his labours. He had arrived at his own opinions, and had aided the members by giving them the grounds on which he had done so. Mr. Holmes Hunt did them the honour to visit Liverpool, and he made inquiries with such care as showed at once that he was anxious to get full information. This, in addition to the fact that many of the members, together with their Chairmen and members of Committee, had visited and inspected the several installations, made them quite familiar with the plants and their working. They congratulated the inventors of each system on the testimony given in each paper. Mr. Drury, in his paper, said the installation, with its auxiliary plant for handling coal and hot and cold coke, had worked most satisfactorily and without a hitch from the time it was first started. Mr. Leather, with his usual candour, referred to early difficulties at Burnley, and was unfortunate in not being able to give absolute figures of make and quality. But he was good enough to give them the benefit of his observations at Lausanne, and the actual results of tests made with various coals—demonstrating that conditions of smooth working had now been realized. This they were glad to hear. Mr. Newbigging spoke with no uncertain sound when he said: "The comparisons between the several systems and the new installation when the same class of coal is used, are beyond all question in favour of the continuous system of carbonization"—meaning, of course, the Glover-West system. It appeared, therefore, that the advocates of the vertical systems claimed to have obtained better results in gas and residuals than could be given by any system of horizontal retorts. This claim, at all events in respect to the gas made per ton of coal, would not pass unchallenged. It would be noticed that the paper on the Dessau system spoke of 12,400 cubic feet to the ton without steam, and 13,400 cubic feet with steam. At Burnley the figures were 12,600 cubic feet and at Manchester 14,200 cubic feet when the coal was squeezed to give the very low illuminating power of 15 candles in a No. 2 "Metropolitan" burner; but when carbonized to give the highest duty in full candles (and many gas undertakings were still working under restrictions as to illuminating power), the make per ton was 11,500 to 12,000 cubic feet. It should be noted, however, that in the three tests given, the calorific value obtained per ton of coal was greater in the case of the large make; and this was an important question when they were all relieved from the illuminating power standard. Mr. Drury had compared the results from the Hendon horizontals with those from the verticals; but his make per ton —10,638 cubic feet—was much below the usual practice, and was hardly a fair comparison. At Liverpool, working under stringent conditions as to illuminating power, the average of all the works—five in number—during the past year was upwards of 12,000 cubic feet per ton. Their colleagues at Longton and Scarborough soared very high, and were in the close vicinity of 14,000 cubic feet; and with this high make they had a very fair quality of illuminating power. The question, however, of the greatest importance was that of cost. If it were granted that a vertical system had advantages—and this was not denied—the question was: What was the price to be? Was the game worth the candle? What had the authors to say on this subject—first as to the cost of an installation, and secondly as to the cost of working? Now, first with regard to an installation. With regard to the Dessau system, Mr. Drury said: "The amount of the contract for the bench complete, exclusive of foundations and coal and coke handling plant, was £10,210." This worked out, on 57 tons of coal per day, at £179 per ton, Mr. Holmes Hunt did not give a definite figure in his paper; but he assumed the cost to be much greater than in horizontals. With regard to the Woodall-Duckham system, no figures of cost were given by Mr. Leather; and as this was of great importance, it was to be hoped that he would, in replying to the discussion, make good the omission. With respect to the Glover-West system, the figure given by Mr. Newbigging, of £8150, or equal to £180 per ton per diem, was very close to Mr. Drury's figure of £179 per ton; but as the latter did not include foundation and coal and coke handling plant, while the former included these items, it was evident that the Glover-West installation was lower in cost per ton than the Dessau one. The next question was: What was the cost of a horizontal installation with a machine stoker? Mr. Newbigging and Mr. Holmes Hunt very properly made a comparison in this respect. The former said: "Modern installations of horizontal retorts, with stoking machinery correspondingly equipped, cost from £140 to £160 per ton of coal carbonized per diem." Mr. Hunt said that an installation on the lines referred to in an earlier paragraph could probably be erected at home for about £100 per ton, including retort-house, all coal plant, stoking-mchines, and hot-coke conveyor. There was a great difference here; and, from his experience, Mr. Hunt's figure was the more nearly correct one. He had with him a statement of the cost of the installation of horizontals with Fiddes-Aldridge stoking machines at their Linacre works—the fourth installation at Liverpool. The working capacity was 250 tons per day, and the total costs were as follows: No. 1 retort-house, at the Linacre station, capacity

250 tons per day, 29 beds of sixes. Cost of installation, R and S benches complete, with settings, bench ironworks, and retort-fittings, £6498 18s. 7d.; P and Q benches, ditto, £7458 4s. 11d.—total, £13,957 3s. 6d., equal to £55·8 per ton. R and S coal-handling plant—viz., breaker, shoots, elevators, conveyor, storage hoppers, joists, platform, ladders, £1898; storage hoppers, &c., extension conveyor, £1535; electrical installation for coal and coke handling, three 60 B.H.P. gas-engines, three generators, five motors, switchboard, cables, spare armatures, £2379 10s. 8d.; two Fiddes-Aldridge stoking-machines, £2500—total, £8312 10s. 8d., equal to £33·2 per ton. Grand total, £22,369 14s. 2d., equal to £89 per ton. These figures included a second Fiddes-Aldridge machine as a stand-by; and in the case of this machine a figure of £80 per ton was allowed. He had the same figures for the other installations; but he would not trouble the meeting with them. The cost of the other installations at the Wavertree and Eccles Street works corroborated the Linacre figure; and it was therefore very clear that the three vertical systems were heavily handicapped by the high cost of installation. Mr. Drury had been kind enough to inform them, in his very able paper, that two stokers per shift, or six per day, did the whole of the charging and discharging, filled and clinkered the producers, cleaned the pipes, swept up, &c., and that their wages represented 7¼d. per ton. For comparison with other places, the wages of the labourers referred to should be added, also the foremen; and they would be glad to know from Mr. Drury what was the total amount of wages paid to men engaged in the retort-house, and dealing with the operations from the coal in the hoppers to the coke on the conveyor. Mr. Leather had not given the cost of working, and might be unable to do so with perfect accuracy in the circumstances of the case. But they would like to receive from him an estimate of the cost, as without such information they were unable to put a value on the system. Mr. Newbigging had stated that one man undertook the whole of the work within the retort-house during each shift of eight hours, and that the wages per day were 15s. 9d., working out at 4·2d. per ton. As the whole of the gas made at the Droylsden works was from the vertical bench, would it not be quite right to add the foreman's wages, and possibly other charges, when comparing other systems and installations? They hoped the author, in his reply, would give them such further information, from his very great experience, as would enable them to compare the costs of working with other installations. Mr. Holmes Hunt, under the heading "Labour Charges," gave a table of tons of coal carbonized per man employed. But while, no doubt, the information helped him in making his choice, there was no definite information to assist the members in making a comparison. It might interest them to know the cost of working at Linacre with an installation of horizontals and Fiddes-Aldridge stoking machinery with Telpher coke-handling plant. The capacity was 250 tons; and there were three foremen, three machine men, three lid men, eighteen coke men (who also pricked pipes and charged the producers), one greaser, four telpher men, and eight cellar men. The wages were £10 6s. 2d. per day, working out at 9·9d. per ton, divided into 5·9d. for coal and 4d. for coke. Mr. Newbigging referred to the pollution of the atmosphere in the manufacture of coal gas. He also referred to the complete absence of all the disagreeable conditions of labour which prevailed with all other systems of carbonization. This was a very fair claim; and, in reference to it, it might be interesting for the members to know that it was possible for horizontal retorts to be discharged without causing the disagreeable features mentioned. At one of the Liverpool works, the coke was pushed out of the retort into an air-tight vessel, which was then closed; and there was an entire absence of smoke. The vessel, with its contents, was immersed in a tank and cooled, no water coming in contact with the coke, and therefore there was no smoke. The coke was found to be clean and bright, it burned without crackling, and it was small—3 per cent. of it passing through a half-inch mesh. They were of opinion that the merit claimed for the vertical retort with reference to cooling was a merit that consisted in the absence of water for cooling; and the coke being treated in the way he had mentioned would produce a quality of coke equal to that shown by the vertical retorts. He would recommend their Dessau friends to consider this point, and thus remove the handicap under which they were working. Mr. Holmes Hunt said a Fiddes-Aldridge machine could not fill the retort. In his (Mr. Allen's) experience, the retort ought not to be filled. Working as they did with full retorts, they found it did not pay so well to work twelve-hour charges as it did to work eight-hour charges. He regretted very much that the Fiddes-Aldridge new chain was not available for experiments; but a chain was being prepared that would enable 13 cwt. or 14 cwt. of coal to be placed in a 20-feet retort—say, 23 in. by 16 in.—and they trusted to get some further information later. But he did not know that it would be wise to put this weight into twelve-hour charges. They got a lower cost of wages and a better quality of gas by working eight-hour charges. In conclusion, he desired to express his appreciation of the labours of the authors of the very interesting papers they had placed before the meeting, and also the members' appreciation of Mr. Wilson's labours, and to give him their very earnest wishes for his success.

Dr. W. B. Davidson (Birmingham) thought the authors of the papers were to be congratulated on what they placed before the meeting. He wished to confine his remarks chiefly to the working results. He agreed with Mr. Allen that, so far as illuminating power was concerned, the results obtained with vertical retorts—whether of the Woodall-Duckham, the Glover-West, or the Dessau system—were not what one would expect, and were not nearly so good as those obtained with the best system of horizontal retorts. One could get results at least 10 per cent. higher with the best systems of horizontal retorts, when making gas of the illuminating value of 17 to 18 candles tested with the No. 2 "Metropolitan" burner. On the other hand, when low-grade gas was required, the vertical retort had a distinct advantage; and he must say that the tests of the Glover-West installation at Droylsden were remarkably good on the illuminating power basis. If they considered the calorific value from the number of British thermal units obtained per ton of coal, it would be found that the Dessau vertical retorts gave by far the best results when making comparatively good gas. If they compared the Grassmoor coal test with the Derbyshire coal test at Droylsden, they would find 10 per cent. difference to the good of the former over the latter when producing the better gas. Strange to say, when making the low-grade gas, there was little to choose between them. He must admit that he could not understand how it was that in carrying out the "B" test at Droylsden the results in British thermal units were so much increased. With Lancashire coal, the increase was 3 per cent.; with Yorkshire coal, 12 per cent.; and with Derbyshire coal, 15 per cent. To get a 15 per cent. increase in British thermal units per ton by simply altering the methods of working was very remarkable indeed. It was as good as Dessau retorts gave with steam. Perhaps Mr. Newbigging would enlighten the members as to how he obtained the results he gave. If they compared horizontal with vertical retorts on the calorific basis when making good gas, the vertical retorts at Droylsden seemed to be distinctly wanting to the extent of 5 to 10 per cent.; whereas at Sunderland the results appeared rather better. He thought it was unfortunate that the make of gas per ton was not corrected on a common basis. It should be carefully stated as to how the gas was computed. Mr. Leather did not mention whether the gas was dry or moist; and this would make a difference of 2 per cent. He considered it would be wise, in determining the heat units per ton, which was a very important matter, to check the calorimeters in duplicate. He had himself found it advisable to have a second calorimeter for checking purposes, because these instruments were apt to get out of order, and give consistently high or low tests. This was especially the case with certain types of gas-calorimeters. He checked daily a Junkers against a Boys calorimeter; and if they did not agree to one-half per cent., he found out what was the reason of it. It was rather strange that Mr. Newbigging should decide on having an installation of Glover-West vertical retorts, in view of the fact that he was an advocate of high-grade gas. He (Dr. Davidson) considered he was losing something if he still wished to have a make of gas having an illuminating power of more than 17 candles when tested with a No. 2 burner; but he should say that he was doing very well if he kept his calorific value at about 500 B.Th.U. The great advantage obtained by a vertical retort was the very complete distillation of the coal; the volatile matter left in the coke being only one-half per cent. Mr. Newbigging compared this with horizontal retorts leaving volatile matter in the coke to the extent of 3 per cent. He (Dr. Davidson) considered this was not good working. The best horizontal retorts left

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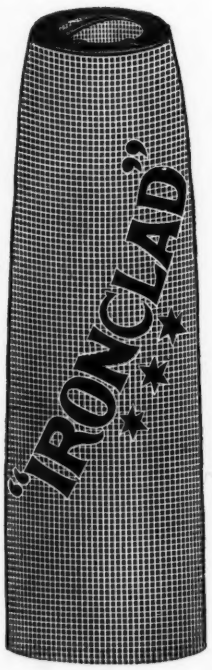

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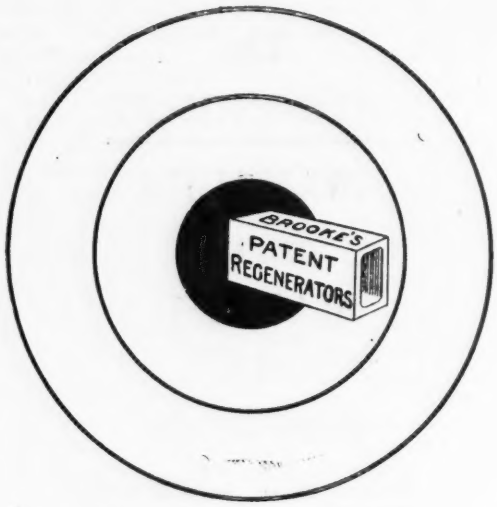

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from 1½ to 2 per cent. of volatile matter in the coke; and he thought it would only be fair, in making comparisons, to compare the workings of the verticals with the best systems of horizontal retorts.

Mr. J. C. Belton (Chester) hoped he would be excused for rising to make a few remarks on the important subject before the meeting, because he did so more as one who was "sitting on the fence" than as one who was interested in the consideration of the difficult problems involved in the papers. Their deepest thanks were due to the writers of these papers for the time and attention they had devoted to the matter, and for the way in which they had laid the subject before the meeting. He would deal chiefly with a review of Mr. Holmes Hunt's paper, which he considered was of the highest value. The whole thing resolved itself into a question of experiment. Those of them who remembered the first introduction of the inclined retort, would call to mind the almost acrimonious discussions which arose as soon as they had three or four different systems of inclined retorts to consider; and the question at that time turned mainly upon the suitability to the particular system of inclined retorts of the coal which was being carbonized. It appeared to him that in the vertical retort they were faced with a very similar question. It was admitted that the particular character of the coal carbonized had a good deal to do, not merely with the results as far as yield of gas and illuminating power went, but with the working of the system; and until this ground had been definitely cleared, and they could find that the vertical retort could be successfully worked with any character of gas coal, he thought those who, like himself, were not in much need of extending their carbonizing arrangements would prefer to wait before turning out plant which was doing good work and installing vertical retorts. There were one or two things in Mr. Hunt's paper he could not agree with. In his opinion, the question of coke and smoke was not the chief consideration. They did not run their works to make coke. They recognized the great value that attached to producing a good coke; but still they had to make the largest quantity of suitable gas they could get, and the question of coke must take a secondary place. Personally, he would never allow the question of coke to interfere with his system of retorts which would give him better all round results. Then the next question was, What were the economies to be looked for from the installation of vertical retorts? On the subject of labour required to work the retorts, he thought there was considerable economy to be anticipated. They had not yet reached perfection in working vertical retorts. They had seen in some of the installations evidence of very great economy. He had been twice to St. Helens, and had seen the Glover-West system working there. He had seen the Woodall-Duckham installation working at Burnley, and the vertical retorts at Manchester; and he could only say that, judging from these brief visits and the information that he was able to obtain, there was no doubt, though the economy at present realized might not be sufficient to justify the adoption of the system, there was economy, and the probability was that, with a little more experience, this economy would be greatly increased. The occupation of ground space was a most important factor to those who had the management of gas-works in confined areas, and was something that they could not afford to lose sight of. The much smaller ground-space occupied by this system of carbonization was a weighty factor in the question of its adoption in works of confined areas. Then, again, they were informed that the wear and tear on this system was considerably less than on the horizontal system. They must accept with some amount of faith the information which came to them from those who had been working the Dessau system a considerable time—that the cost of the wear and tear (that was to say, the renewals) was about one-half that with the horizontal system. If they took for granted these three advantages—namely, economy of space, the reduction in labour cost, and the saving in the expenditure on wear and tear—what remained? What were the advantages in the manufacture of gas itself? Here he must differ from Mr. West and Mr. Glover—in fact, the whole congregation of vertical men. He was sorry to have to do so; but he did not see that there was any difficulty at all from a gas producer's point of view. He was not just then considering the question from the point of view of cost, but the cost itself. There was no advantage in illuminating power, no advantage in yield of gas per ton, and he could not see that there was any advantage in calorific value. With a good installation of horizontal regenerators worked by manual machinery (which was not the most economical system to be had to-day, but at his works it would not have paid to adopt a more elaborate and more economical system), they were now getting per foot of retort 1000 cubic feet of 17-candle gas tested in a 15-hole argand burner with a 7-inch chimney. The average test was about 515 B.Th.U. He did not think better results had yet been obtained by any system of vertical retorts. Therefore the advantages were all on the side of the economies to be effected. Next, there was the ease of manipulation and the better control of the heats, and perhaps the quality of the coke. These were secondary considerations; but they were all too important to be lost sight of. The result of this system of working on the other residuals had not yet been definitely ascertained. He held that the time the system had been working at Sunderland was too short for the results obtained there to be accepted as final; and they must wait with patience until they really knew what the results on their sulphate and tar and sulphur compounds were going to be. What he had said summed up the position from the point of view of the man on the fence. Before deciding on the character of any extensions to be carried out, undoubtedly, with these facts in front of them, the fullest consideration ought to be given to the claims of the vertical retort system.

Mr. Thomas Glover (Norwich) said he spoke as one who was interested in the subject of carbonization, and also as one who was concerned with the reputation of his country and his countrymen in keeping up to date, and maintaining a reputation for being able to provide the best form of carbonizing plant for use all over the world. He remembered that he was the means of helping to start these discussions on carbonization, which had now become hardy annuals, in the year that Mr. Körting first introduced the Dessau system in London. Since then they had made great advances, both in that system and in designing and working vertical retorts in this country, as well as in the alteration and improvement in the working of horizontals. At that time, he recommended the retention of the free space above the charge; but he had since gradually become a full-retort man, and had been working for three or four years with chambers quite full. He had begun to fill up the ⏢ retorts, till they also worked quite full. This had helped him to make certain comparisons. Mr. Holmes Hunt's review was an exceedingly able one; but he (Mr. Glover) thought it was almost too thorough, because he had gone over the ground well in the first place, and had then zigzagged backwards and forwards. As he said, the result was an exceedingly interesting review, but the essence of it was that he was in the position of one who, at a critical period in the history of the development of gas manufacturing plant, had of necessity to dip into the carbonizing melting-pot, and had, for the moment, taken out the Dessau system. As a Britisher, he felt that it was a great pity that British engineers who had this matter in hand were not ready at the time to convince Mr. Holmes Hunt that they had the best system. He fancied, if that gentleman were to come over again in a year or two's time, his decision would be of an entirely different character. One of the points which had decided Mr. Holmes Hunt was the fact that the continuous system required continuously working machinery. He thought that those who had seen the machinery would not be alarmed, because its simplicity would remove any anxiety on that score. Then, again, the question of the cost of labour was another point which had decided Mr. Holmes Hunt in favour of the Dessau system. He need only, therefore, refer to the Sunderland cost, because there they could do it cheaper. With regard to the question of the quality of coke, he fancied those who had vertical retorts in hand would be able to deal with this. It was very characteristic that the sulphur and the naphthalene had been very considerably reduced. It was a fact that with full horizontals, while the sulphur was very much lowered, the naphthalene was almost absent. With regard to the labour costs, in Norwich, with full retorts and 13 cwt. charges of twelve hours' duration, the retort-house cost was 6·97d. per ton. The Dessau cost at Sunderland appeared to be 7·25d.; and according to Mr. Newbigging's paper, in the Droylsden retort-house it was 4·2d. So that the difference in favour of the vertical system there was very considerable. With regard to the fuel per 100 lbs. of coal, at Norwich they were

doing with 13·8 lbs.; with the Dessau system, 17·8 lbs.; and with Glover-West's system, according to Mr. Newbigging, 10·36 lbs. This was an important point; and it would be interesting for the Carbonizing Committee to prove how much heat was lost by diffusing it into the air when they pushed out the coke on to the retort-house floor and quenched it. He had constructed a simple calorimeter, to ascertain the heat of hot coke; and the heat units came to about 2 per cent. on the fuel used. This he found practically agreed with the Manchester results, which were about 2 per cent. better than his; because he lost all his heat by pushing the coke on to a conveyor and quenching it with a water-jet. The continuous vertical system led to a great conservation of heat—the heat of the coke being returned into the retort; but with an intermittent system it was impossible to do this. In his opinion, no system could make such a good use of heat as a continuously worked vertical retort, as the heat from the spent charge was returned to the setting. The heat which was lost from the gas was also an important thing; they lost heat by condensing it in the ascension-pipe. He fancied those who had in hand the vertical system would be able to make some use of the heat lost in the gas. Another point with regard to the Dessau system was the temperature of the gas leaving the retort, which appeared to be an average of 176° Fahr. at the bridge-pipe. With full horizontals, the temperature was 160° Fahr. in one case, and 175° Fahr. with chambers, which matched very closely the Dessau system; and he asked the Glover-West people if they could give him the temperature of the gas leaving theirs. He ascertained that it was 140° Fahr.; so that they were making some use of the heat from the gas. There were one or two slight inconsistencies in the analysis of the gas in Mr. Drury's paper; but they were not important. When steaming, he found there was less carbonic oxide shown in the analysis of gas, and less carbonic acid; but he would not pause to deal with such fine matters. It seemed to him that they could gain almost all the advantages of the Dessau system with their present horizontals, if only they were equipped with suitable machinery. They had a very fine coke, and a better quality of tar, and an improvement in the naphthalene, as well as a reduction in the labour cost.

Mr. J. W. Broadhead said, as a member of the Society of British Gas Industries, and as one who was deeply interested in the carbonization of coal by means of vertical retorts, he was indebted to the President for having invited him to be present to listen to the able papers put before the meeting, and also for allowing him to take part in the discussion. Mr. Newbigging seemed to take exception to all other systems of carbonization as being unscientific. A large amount of money had been spent on different systems, and each one connected with them was quite satisfied that the results obtained from his own were the best possible. He (Mr. Broadhead) also thought Mr. Newbigging claimed too much on the head of the human element. In the continuous system described by him, in which he found there was intermittent charging and discharging, the speed at which the carbonization took place was controlled by means of certain appliances at the bottom of the retorts. It looked to him as if the human element required to adjust these speeds must be of a higher intelligence than was necessary in the intermittent system, which was practically "fool-proof." Mr. Newbigging charged the users of the intermittent system with putting an irregular quantity of coal into the retort, and allowing it to stop there for an irregular period—not caring whether the coal was over or under carbonized. In the continuous system, the coal was allowed to stew in the retort for ten or twelve hours. With the Glover-West system, he thought it was a comparatively much shorter time; with the Woodall-Duckham system, six or seven hours; and with the intermittent system, eleven or twelve hours. It was only by examining the result in coking that the gas maker knew whether the coal had been over or under carbonized. Surely, in all systems, when the quantity of coal was changed the necessary regulations were made. Mr. Newbigging only claimed an advantage of 500 to 1000 cubic feet of gas per ton of coal carbonized, compared with other systems under his control, when carbonizing on the same basis. Was this the sum of real benefits to be expected in quantity when working under Manchester conditions? Mr. Newbigging did not claim preference for the continuous system when the quality of coke was a consideration. He (Mr. Broadhead) ventured to say that the quality of coke in all towns was a matter of great importance. Page after page of Mr. Holmes Hunt's paper went to show that many local factors would operate in favour of the intermittent system. He had had a slight experience with the Settle-Padfield process; but it was confined to the intermittent system in operation at Cleethorpes. The members would be interested to know that a new retort-house, containing forty retorts, or four units of ten retorts each, was being built there. Their experiments had been confined to one works only, which accounted for so long a time having elapsed before the results had been put before the profession. The first installation was not found very successful. It was first remodelled, and then pulled down and rebuilt with a new unit of ten, which had been in continuous operation, with one set-back, for a period of practically eighteen months, during which it had distilled about 6000 tons of coal; and the retorts were in very good order. He considered the cost of resetting the retorts would be considerably more than with horizontals. The installation was altogether too costly to enable them to put it on the market; and for this reason another was built at the far end of the house, and it had been working for five or six weeks. It was too early to say much with regard to it, but a recent six days' test conducted by their own men had resulted in a make of 13,000 cubic feet of 16-candle gas tested with a No. 2 burner, from a mixture of South Yorkshire and Derbyshire coal. With regard to the Sunderland installation, he observed that when the coal was elevated into the roof, it was screened. This, in his opinion, would give rise to a certain amount of nuisance from dust, apart from the fact of increasing the height of the building. The object of screening the coal into large and small was not achieved in the retort. When the two classes of coal struck the angle of the shoot, they would mix with each other. As they were going into the retort, they would further mix; and the coal in the retort would practically be in the state in which it was when it came out of the railway waggon. It would be interesting to know what the back-pressure was on the bottom mouthpiece when the coal was dumped into the retort. When first taking up this subject, he had a retort constructed with a movable front, and charged it with a system which had been described to the meeting. The retort was carefully laid on the floor, and the front removed, with the result that where he expected to find small coal there was about 5 per cent. of large. This led to a different method of charging the retorts—that was to say, introducing a shoot into them, which discharged the coal against the side of the retort, with the result that when the small reached the bottom it stopped there and formed a bank down which the large pieces rolled. By this means two quite distinct columns of large and small coal were formed in the retort, and the effect was that at Cleethorpes there was never more than an inch of back-pressure, which was an advantage. It was known that the capacity of a retort varied to the extent of 1½ cwt., whether it was newly scurfed or ready for scurfing. At Cleethorpes, each retort measured its own charge. The shoot was also provided with a screen which fitted the top face of the mouthpiece, and thereby a large amount of smoke was done away with. From experiments he had made, he was quite satisfied that an intermittent system would be evolved before long which would be quite free from the smoke nuisance. They had recently made experiments at Cleethorpes with the view of reducing the heavy tarry matters. These were not a nuisance; but the less heavy tar that was formed the better. They put a layer of breeze on the top of the coal immediately after it had been charged. He should like to refer to the Toogood door, which was operated by a single pull. It looked as if it were out of plumb; but the coal coming out of the retort could not interfere with the sealing of the lid. Perhaps he might ask Mr. Drury why the gas was subjected to a cracking process in passing through the top 2 ft. 6 in. of empty retort. He thought completely filling the retort was an essential feature of the Dessau system. He should also like to know the conditions peculiar to English practice which rendered improvement necessary, which were not applicable to Continental practice. He thought that as long as the consumer obtained a constantly even quality of gas, it mattered not to him how it was produced; and it was interesting to find, from Chart "C" in Mr. Drury's paper, that the intermittent system provided a gas equally constant in calorific value to that produced by the continuous system. Mr. Holmes Hunt, when speaking of various machines, did not mention the Dempster, which was in successful operation up and down the country. He would not have referred to this machine except for the fact

that he was not quite satisfied that coal carbonization in an unscientific horizontal way was yet dead. He expressed the opinion that in process of time it would be shown that the intermittent system possessed advantages of its own no less than the intermittent system.

Mr. J. F. Bell (Derby) said the papers had been treated in a most inspiring and interesting manner by the four authors. They had had two systems brought before them —first, the Dessau intermittent carbonizing system, with completely filled retorts; and, secondly, the Woodall-Duckham, which might be termed the pioneer system. After this came the Glover-West system, which was something similar to the Woodall-Duckham; and then, further, they had had a few words on the combination of the two systems. He was sure he would be only voicing the wish of all the members present, when he said he hoped the President would made good his promise in a year or two to deal with this subject. Before saying anything on the vertical system, he desired to say a few words with respect to their old friend the horizontal system. His advice to all the members was that, before they adopted this new so-called scientific method of carbonizing, they should be quite certain they got something which gave results equal to that which they were now getting with their horizontals. Horizontal retorts had served them well in the past; and, after carefully reading all the four papers on vertical retorts, he still adhered to his previously expressed opinion that there was as yet no case made out for scrapping modern horizontal fittings. But where the horizontal retorts were worn out, obsolete, or additions were required, he thought the various systems of verticals were well worth serious consideration. It seemed to him that, in any criticism of either intermittent or continuous systems of carbonization, to label one "Scientific" and the other "Unscientific" was inadmissible. Both had special merits which entitled them to impartial consideration; and he could well understand that, while to one engineer the intermittent would appeal, to another the continuous would appear to be more suitable. With all respect to Mr. Newbigging, he could not imagine why coal slowly moving downwards in a vertical retort was likely to be carbonized in a more effective or more efficient manner than similar coal remaining stationery. In both cases the coal was subjected to different stages of heat—in one as it moved downwards, and in the other the heat passed towards the coal—and it seemed to him that the total final result in respect to gaseous products would be very much the same, provided the gases liberated were not subjected to harmful or destructive treatment later, which was found to be somewhat the case with partially filled horizontal retorts. He could quite conceive that, with inferior caking coal, this downward movement while the coal was in a more or less plastic condition would be prejudicial to the resulting coke. Further, a system which, so to speak, simply up-ended the horizontal retort, which was charged full at one operation by gravity (there was an absence of mechanical parts), working in a warm and dusty atmosphere (which appeared inseparable from the continuous system), was not one which was likely to commend itself to engineers. He knew that it had been the aim and ambition for the last fifty or more years to have continuous carbonization, because there was an absence of smoke and steam and the conditions of labour in the retort-house were improved so long as everything worked smoothly; but the question was which system of verticals would be ultimately found to be the best—that was, if there was a best, which he very much doubted. The names of Dr. Bueb and Mr. Harold Woodall would always stand out pre-eminently as the pioneers of the intermittent and the continuous vertical retort systems. Turning to Mr. Drury's paper on the Dessau vertical retorts at Sunderland, it would be generally granted that the author had given them a concise and candid record since the installation started gas making, now some eighteen months ago. He was very glad that Mr. Drury, instead of giving them solitary tests, had given the result of twelve months' working. It was much more satisfactory for engineers to give the results of tests embracing as long a period as possible, because, when short tests were made, errors sometimes crept in, which longer periods would eliminate. Mr. Drury had been good enough to refer to certain tests carried out at his (Mr. Bell's) own works at Derby. He desired to express his obligation to Mr. Drury for his kindness in placing the Ayres Quay Gas-Works at his disposal, in order to make some tests of Derbyshire gas coal in vertical retorts on the Dessau system, which were carried out from Jan. 17 to 20 last; arrangements having been previously settled to make the trial as complete as time would allow. He would not trouble the members with a description of the plant sent from Derby and the means they took to make the tests as carefully and accurately as possible; but he thought Mr. Drury would agree with him that they took all possible precautions to ensure that the tests should be accurate. His only object in sending a consignment of Derbyshire coal was to see whether they could get better results with vertical than with horizontal retorts. When he started, he was rather sceptical, because he thought they could get as good results with filled horizontal retorts as with verticals. But the result of the test, extending over the four days, had convinced him that they could get better results with verticals than with horizontals. In this case, it amounted to something like 1000 cubic feet of gas per ton. There was a decided increase in the quantity; and if they took the product of the cubic feet multiplied by the heat units, they found they had an increase of something like 18 per cent. In carrying out the tests, there was a point which struck him as very remarkable, and that was the large increase obtained in the quantity of gas in steaming, with a very small reduction in the heat units in heating. Then, again, the carbonic acid was almost stationary, varying only between 2·3 and 2·6 per cent. The calorific value also was very constant and uniform. The sulphuretted hydrogen seemed to increase and decrease in a remarkable manner. With regard to sulphur compounds, there was a considerable increase—much more than he expected. He believed the amount of sulphur compounds from Derbyshire coal was double that which Mr. Drury got from Durham coal. This was easily explained, because there was more than this quantity of sulphur in Derbyshire coal experimented with. The cyanogen with the vertical retorts was somewhat lower than with the horizontal. With reference to tar and liquor, they were unable to get any results, because, in dipping the wells, they did not get the quantity of liquor they expected. They were not quite certain with regard to the ammonia; and therefore he did not refer to it. He thought Mr. Drury said there was an increase of 20 per cent. He would next refer very briefly to Mr. Newbigging's paper, the title of which should, he thought, have been "The Glover-West System of Continuous Vertical Retorts," instead of "The Scientific Carbonization of Coal," because it was a description of the system as erected at Manchester. He was sure they would all congratulate Mr. Newbigging on the paper he had placed before them; and they would also very heartily congratulate their friend Mr. West on being able to evolve, along with his co-patentee, Mr. Glover, such a very successful system. He ventured to think that Mr. Newbigging's communication would have been much enhanced in value if, instead of giving certain isolated tests, he had given a record extending over a certain number of months, in the way Mr. Drury had done. Mr. Newbigging had told them he was able to isolate the gas and keep the returns separate. But he did not put the returns before them; he simply gave them the results which would be found in the table in the paper. On looking over these tests, the first thing which struck him (Mr. Bell) was the remarkably low percentage of moisture—viz., 1½ per cent.—contained in the coal. He only wished he could buy coal with this percentage of moisture. In his experience, Derbyshire coal contained 5 or 6 per cent.; and if these tests had been carried out with coal containing this percentage, the moisture would, of course, make a material difference. Another thing which struck him as peculiar about these tests was that with Yorkshire coal the sulphur compounds in the gas were higher than with Derbyshire coal, which contained a high percentage of sulphur. What he had been saying seemed to point to the fact that the tests required consideration. He had tried to take out a coal-balance, because he was specially interested in the tests of Derbyshire coal. He had totalled them up; and, while he was not going so far as to assert that Mr. Newbigging had given them more than 20 cwt. to the ton, he would say that he was getting very near the danger-line. The difficult point was that he did not know what quantity of liquor Mr. Newbigging added to his gas. He should like to know at what temperature Mr. Newbigging worked at the different zones in the retorts. It would add materially to the value of the paper if this could be given. With regard to Mr. Leather's paper, he was sure they were all much indebted to him for placing before them in such a concise and fair manner the difficulties he experienced in working the Woodall-Duckham system of

continuous carbonization. Very often more was to be learnt from failures than from successes; and it required somebody with some amount of courage to come forward and tell them of his difficulties. Mr. Hunt had placed before them a very valuable paper. He, personally, was very much indebted to that gentleman for going through the different systems, and dealing with them in so comprehensive and fair a manner; and he was quite certain that his paper would repay careful reading, as it would be helpful when they were considering what system of carbonization they should adopt.

Mr. H. L. Doherty (New York) said he must confess he had never seen a vertical retort in operation until the previous day. He was greatly impressed with the system proposed by Mr. Wilson, because he believed it possessed some very great advantages, and was worthy of serious consideration. Mr. Wilson's system seemed to have been more or less neglected in the discussion which had taken place; but he supposed this was because he had not read a paper on it. It would, perhaps, be interesting to the members to learn that in America, without any communication between Mr. Wilson and himself, they had both hit on the same plan of dropping the charge after a certain period of time. His theory was that if he could first form a shell of coke round the coal, he would get a better quality of coke. He was unable to agree with the suggestion that gas makers were not interested in the production of coke. It seemed to him that they would find out that the coke they produced was of more value than the gas; and that in order to cheapen the gas they must look primarily to the value of their coke. In spite of the reference made by Mr. Holmes Hunt to the value of coke, he had not heard anyone touch on the problem of making metallurgical coke in a vertical retort. With them in America it was either vertical retorts or coke-ovens; and most of them felt that unless they could make in a vertical retort a metallurgical coke that would do for a blast-furnace, they had better adopt the coke-oven, which had the advantage that it was used to make gas to a very considerable extent. He was one who believed they could make metallurgical coke in a vertical retort; but if they could not, they would get a higher price for their coke-oven coke to pay for the extra cost of gas manufacture. In other words, their net cost would be less with the coke-oven, unless they could make a good metallurgical coke. He was anxious to know if they could produce a good coke in a continuous retort, as they could with a strictly intermittent system. He was quite convinced that the coke in the intermittent system was the superior product. They were afraid of the continuous system, because they anticipated that the continuous charge would cause fissures in the coke, and that therefore the coke would be rendered less valuable. It seemed to him that the continuous system was undoubtedly the best. He agreed with the previous speakers that it could hardly be spoken of as a scientific matter.

Mr. Samuel Glover (St. Helens) said he was not ashamed of admitting he was the god-father of the coke at his end of the table. He would not discuss fully the papers that had been submitted to them. He could have done it with very much more sportmanship if the writer of the long review on carbonizing systems had been there to hear the criticisms that had been brought to bear on some of his conclusions. He thought Mr. Holmes Hunt would find that his conclusions with regard to the Dessau system of carbonizing coal in vertical retorts on the intermittent system were contradicted by the results obtained from both the continuous and the intermittent system as operated at the Sunderland works. Mr. Holmes Hunt's argument, based on his conclusions from the working of the longer intermittent retorts—that he would look for better results from the intermittent system—was contradicted and not realized. There was now being waged what had been called a battle of giants. In the words of the Lord Provost on the previous day, it was a good thing to find oneself in a vertical position in these days. At St. Helens they had been in this most interesting position now for nearly three years; and to-day the setting which so many gas engineers had seen at work was still going strong without having had any noticeable wear of the simple machinery. He could not agree with the gentleman who said that a large make of gas per ton of coal could not be obtained. He would take Mr. Belton's results, and give him certainly a larger quantity of gas per ton and better results in calorific value. He was concerned in the quality of the coke which their system would turn out. He claimed that the vertical system, whether it was the intermittent or the continuous, produced better coke; and if the making of coke was to be the first consideration, they would have to look at things from this point of view. But circumstances altered cases; and one could not get something from nothing. If they had a coal that would not produce a good coke, they could not make it into a good coke by any process of carbonization. He could not sympathize with the fear that some of the carbonizing engineers had that the coal in a melted state would roll away and break up. The retorts had been designed in such a way that the descent of the coal was such that as the coke swelled the increased size of the charge was provided for by the increased size of the retort. He had every confidence that Mr. Newbigging would be able to answer all the questions that had been raised; and he (Mr. Glover) did not wish to anticipate him in any way. He wanted, however, to draw attention to the aims with which they had started out. Many of them had travelled along with him in some of the details of the system; and he would remind them that they aimed at providing an apparatus so constructed that heat of various temperatures was applied to different sections of the retort in such a manner that the volatile matters were as rapidly as possible destructively distilled out of the coal progressively, and so that they were evolved without being exposed again to heated surfaces in passing out of the retort. A process by which the coal that had been subjected to the gentle heat at the top of the retort gave off a gas that was more readily decomposed, was one that did the work much more scientifically than any other. He was quite prepared to submit this to the arbitration of carbonizing engineers, either in Great Britain, where there were some of the best, or throughout the whole civilized world. He could not give any one temperature which represented that at which the coal was carbonized, because coals were carbonized intelligently at many varying temperatures in different parts of the retort. The system provided for this. It was purposely devised to give the carbonizing engineers control of the length of the retort vertically in horizontal chambers, so that the heat could be given progressively, differing with the quality of the charge that had to be dealt with. [Several members signified approval.] He took it that he had made this point clear. The recovery of the heat for use in the setting was a thing that carbonizing engineers had dreamt about, and in connection with which some of them had "seen visions." They had now seen in reality the recovery of the heat of the coke back into the setting. This brought about a saving of 2 per cent. If they had done nothing more, they had done something which would help the carbonizing engineer to make better use of the coal Nature had provided for them. He had recently started at St. Helens one of the new settings, the results from the working of which all went to prove the correctness of Mr. Newbigging's results. Mr. Newbigging had given them what they would look for when they investigated a coalfield to see what the coal would give on testing. They could not arrange a contract in March or June if they had to wait twelve months for results. A test of Wigan coal given with their new form of coke discharge, which was simply an inclined plane on which the free coke was allowed to slide down when it was required, was the better one. There were before the members a few specimens of coke which had been taken from the barrows, and which was representative of the whole. Of course, there were some smaller pieces. The test of this coal which had been sent to him showed a make of gas per ton of 14,357 cubic feet, with an illuminating power of 14·5 candles, and a calorific value of 541 B.Th.U. gross and 496·8 B.Th.U. net, and a fuel account of 11·3 per cent. The analysis of the gas would be interesting, inasmuch as it showed that of carbon dioxide there was 1·7 per cent., no oxygen, unsaturated hydrocarbons 3 per cent., carbon monoxide 10·3 per cent., methane 27·23 per cent., hydrogen 55·10 per cent., and nitrogen only 2·69 per cent. The pathway through which the gas travelled in the continuous retort was a very natural one.

Mr. Philip G. Moon (Bournemouth) expressed the hope that the meeting would pardon a young member of the Institution rising to speak on the papers, and would not put it down to presumption, but to a very keen interest in vertical retorts, due to an association of some five or six years with their working at Bournemouth. He wished to offer a few words of congratulation to both Mr. Newbigging and Mr. Drury on the completeness of the records they had

placed before the members. Dr. Lessing, in his carbonization report, asked for uniformity in the presentation of these reports; and he (Mr. Moon) thought the papers by these gentlemen showed that tendency towards uniformity which was so desirable. He should like to say that it seemed to him that the meeting marked the entry into manhood of continuously working vertical retorts. They had had the reflection cast upon them for some years that they were still in the experimental stage; but this would no longer be justified, now that they had had the results from the installation at Droylsden, which had been working for twelve months, and also those from Lausanne—a town of considerable importance, with a high standard of lighting to maintain. When he told them that these retorts had been working for six months, and that no other gas of any sort had been made, he thought they would admit that continuous carbonization had at any rate proved that it had a place in the practical affairs of gas engineers. The members might be interested to hear the results obtained from Lausanne, not over one or two special test-periods, but regularly since the first day the retorts were put to work. They were 12,962 cubic feet of gas per ton, 598 B.Th.U. gross, 532 B.Th.U. net. The fuel account over the whole period was 12·1 per cent. These figures covered periods when the retorts had had to be worked slowly owing to restricted output. The B.Th.U. per ton over the whole of the period was 7,751,000 cubic feet, against 7,900,000 cubic feet from the vertical retorts at Sunderland over a special test, and 7,800,000 cubic feet with the vertical retorts at Droylsden. Taken over a long working period covering varying qualities of coal, including a good German coal, very bad French coal, and English coal, requiring different working conditions, these results served to prove that continuous carbonization was a thing of practical moment to engineers. There was one thing he should like to say about the difficulties encountered, of which there had been much talk. Of course, they had been encountering difficulties. It would be taxing their credulity very much to ask them to believe anything else. When one set out to solve a problem of the complex nature of continuous carbonization, it was only to be expected that difficulties would be encountered; but it was rather to the credit of the engineers engaged that, in the comparatively short period that continuous carbonization had been in existence, they could produce the figures that had been placed before them by Mr. Newbigging, and also those which he had the honour of putting before them. A great deal had been said about the sample of coke being good; but perhaps he might say that the adjective "good" depended entirely on the purposes for which the coke was required. If metallurgical coke was wanted, he was not certain that, in the present state, continuous vertical retorts would supply them with it. On the other hand, if household coke, with a low ignition temperature, were required, then he was quite certain that these retorts would supply it. In Sir Roberts Austen's treatise on metallurgy, there were given some very interesting experiments on the value of different fuels; and these summed up pointed to the fact that the difference in ignition temperature, depended to a great extent on the physical characteristics of the fuel, and on the gas it contained. Continuous vertical retort coke did not contain any residual gas; but it did differ from horizontal retort coke to some extent, in that it was of a more open nature. It was produced at a lower average temperature, and it had a definitely lower ignition-point than ordinary horizontal coke. This was the direction in which the advocates of coalite were endeavouring to work. They were all trying to produce coke with a low ignition temperature. The fact that they could produce coke of this character in continuous vertical retorts was a point in their favour. He thought it was Mr. Allen who had said that there were no figures given for the capital cost of vertical retorts by the Woodall-Duckham system. He might tell them that the figures worked out, including coke and coal handling plant, retort-house, retort-benches, and everything except foundations, at between £130 and £140 per ton.

Mr. John West (Manchester) wished to thank the authors of the papers for the valuable information they had had placed before them. Mr. Drury had certainly supplemented the information they had obtained some years ago from their friends who investigated the Dessau system. He referred to the experiments made by Dr. Colman and Mr. Broadberry. It appeared to him that they practically agreed as regarded the make of gas; but the information had been very much supplemented by the twelve months' further experience, and also by what they were told particularly about the labour cost, the percentage of fuel, and so on. Mr. Drury's paper was a very valuable and fair one, and was just what he would have expected from him. While they were thanking the authors of the papers, he thought their thanks were also due to the Chairman and Committee of the City of Manchester, and also to the Chairman of the Gas Committee of St. Helens, for allowing them the opportunity of working out these systems. Both of these bodies had spent large sums of money in providing subsidiary plant apart from the retorts, so that they could have a large experiment in order to work out everything in minute detail. He thought that they, as an Association, should accord to them a vote of thanks for their kindness in enabling the work to be carried out. There were one or two remarks in Mr. Hunt's paper which were very valuable. The paper gave an exhaustive summary of the many systems that he had seen throughout Europe; but there were one or two corrections which, in justice to himself, he wanted to make. The author said, when speaking about the continuous system of carbonization, that his investigations had left him somewhat disappointed, and that, in his opinion and judgment, it was not so continuous as he imagined. He also said that the only one which appeared to have been aiming at continuous working was the Woodall-Duckham. In answer to this, he would ask them to look at the drawing on the wall, and say if that was not continuous. All they had to do was to turn the top valve on, and let the coal in. The weight of the coal was on the top, and it would be continuous. Mr. Hunt had said that the Woodall-Duckham was more continuous; but, in his (Mr. West's) opinion, it was not so. Between the valve and the top of the retort there was the method of feeding it in a bit at a time; and they had been told that this was not a success. As proof of this, they had complimented him and given him a very high testimonial by adopting his system of dropping the coal on the valve just as he did. He did not blame them, because it was the best thing to do. There were a good many errors of this class in the papers, Mr. Hunt said that the possibilities of both systems had at the moment to be judged mainly on opinion, theory, and surmise. He (Mr. West) had given no opinion based on theory and surmise. What he had done was to give the absolute undeniable testimony of independent gentlemen of the highest position. He would rather leave it to the authors to make tests, as he would rely upon their superior scientific evidence before his own. The author said three systems were tested. He would like to say that there was no satisfactory test made at Manchester. Mr. Hunt had asked them if they could make a test, and he had assented, and suggested that he should let them have 200 tons of coal in order to do so. This was understood; but they did not get the 200 tons or anything like it. It was impossible to make a test in a few hours of coal coming from Australia which they knew nothing whatever about; so that this was an abortive test. In fact, it was a farce. Coal could not be tested in vessels of this character in a few hours. Mr. Hunt was responsible for the test; and therefore why did not he let them have sufficient coal for a proper test? If he had done this, the results would have been forthcoming, and the information which was given now could have been obtained long ago. Mr. Hunt also came to the conclusion that the Dessau system was cheaper in many respects—one being labour. Now, he had had the opportunity of getting from Sunderland what it had cost; and that was found to be 7¼d., which was dearer than could be done with the horizontals. He had also got to know what the cost was at Manchester. All this information was obtainable then, just as it was at the present time. Therefore he did not know why Mr. Hunt should come to the conclusion he had arrived at. That gentleman had said, time after time, that he assumed that it would come out in this or that way; but assumptions were no good to them. They wanted facts and figures. It was also stated that there were no tests for fluid residuals. In reply, he would say that he had given all the tests he could give on this point; and if they would look at the records that had been worked out for them, they would see they were to the advantage of the fluid residuals. His desire was not to theorize, but to go on working, and give undeniable proof by independent testimony as to the value of the apparatus that had been put up at St. Helens. He would have an opportunity very shortly of testing the Australian coal, and would let them know the value of it.

Mr. Hunt had the satisfaction of knowing that they could carbonize his coal at something like half of what it cost at Sunderland.

Mr. CHARLES HUNT (London) said he was quite sure Mr. Glover would not desire to do an absent man an injustice. He would remind him that the figure given by Mr. Drury as to the carbonizing cost at Sunderland was not that which influenced Mr. Holmes Hunt in arriving at his decision. This was stated explicitly in the paper. It must be remembered that the Sunderland installation represented the earliest effort of the Dessau system, and that considerable improvements had since been made; a notable one being the introduction of a bed of 18 retorts, three of which were drawn at one time. This had effected a reduction in the labour account of somewhere about one-half. The recent figures given by Mr. Körting showed that for an installation of 500 tons 28 men only were required, including three foremen. This was the whole of the carbonizing cost; and members could work it out for themselves on their own rate of wages. He estimated that the cost was somewhere under 4d. per ton of coal carbonized.

The PRESIDENT said he thought eventually each of the systems would find its own corner, and that each one would be found to suit some local circumstances. In the meantime, he was sure the papers to which they had listened, the discussion they had evoked, and the replies they were about to hear, would help them all very greatly in their knowledge of carbonizing routine. He did not think the members had ever had such an opportunity of getting at the facts and figures.

Mr. DRURY, in reply, said the paper he had had the honour of reading before the Institution was a non-contentious one; and it aimed at being a record of the results obtained in eighteen months by the Dessau system in Sunderland. It was, as they had heard, not the latest. The later system, of course, introduced many improvements on the one they had at work, and could be worked comparatively cheaper. Some of the remarks that had been made suggested the early consignment of any non-continuous system to the scrap heap; but he had still sufficient faith in the Dessau system to believe that it would survive, and in the end prove the fittest of all the systems, especially when dealing with a difficult coal such as they had in Durham. No doubt there was a subtle charm in the automatic feeding of coal into retorts, and in the evacuation of already cooled coke. So long as the coal was suitable, and everything went well, no doubt it was very pleasant; but he still contended that there were very great advantages to a practical man in seeing the inside of a retort once a day, to ascertain what condition it was in, what was the state of the coke, and also to see that the charge of coal was safely in when it was charged, and that it was there till the end of the carbonizing period. He could not admit that a non-continuous system was necessarily unscientific, since in every-day life results were often produced by both continuous and intermittent processes; and it was not always that the former method was the better. For instance (to take a homely illustration), many people when at their hotels still preferred their cup of tea made by the intermittent system to that produced from the use of a continuous tea-making machine. He also considered that it was quite possible to stew coal in a continuously working retort, and quite unnecessary to do so in an intermittent retort. In each case it required adjustment to prevent this effect coming about. In the case of the continuous system, one had to adjust the stroke of the charging arrangement, which could only be ascertained after seeing the coke coming out for a certain length of time in an unsatisfactory condition. In the continuous system, one could see at once whether or not it was going on properly. Mr. Allen had mentioned the Hendon results. Of course, he did not put forward these as being ideal, or as being an example to anyone else. As a matter of fact, at the Hendon works they still had a certain number of retorts heated by an antiquated system; and his Directors had decided not to go in for any large expenditure of capital while there was so much discussion as to the best form. With regard to the cost of the bench not including the foundations, he might say that these cost £270; bringing up the figure to £184 per ton of coal carbonized. Looking to the total carbonizing costs of the retort-house, for stokers they came to 7·25d., then there was the coal and coke handling 1·37d., and for foreman and scurfers and so on 2·3d.; bringing the figure up to about 11d. per ton of coal carbonized. It must be remembered that the whole of the plant was laid out with the idea of duplicating it at an early date, and the cost was therefore greater than it would otherwise be. The figures were based on the weight of coal per diem. Dr. Davidson had asked whether the make of gas was estimated in its dry or moist condition. The answer was that it was in its moist condition. The same gentleman had also referred to the advisability of checking calorimeters. This was done at regular intervals. Mr. Belton had said that it was rather early yet to judge of the results of their system. He would point out that the figures given in his paper covered an absolute working period of twelve months. Mr. Glover had raised a point with regard to the labour cost at Sunderland. There was no doubt that the cost was rather heavier than some people anticipated; but it must be remembered that it was all hand work—there was no mechanical feeding. With regard to the Droylsden results, of course to the amount for labour must be added the cost of the gas used for the extracting arrangement, which would be ¾d. a ton; and there would also be the upkeep and the wear and tear of the machinery. While replying to the criticisms on his own paper, he wished to congratulate Mr. Newbigging on his most excellent fuel account result, which was certainly one of the lowest he had ever come across. At the same time, it must be admitted that the fuel account would very greatly depend on the nature of the coal they were dealing with. Their coal at Durham contained, on the average, 10 per cent. of ash, and a very large amount of dust—fully 37 per cent. of the coal was dust. Mr. Broadhead had mentioned the stewing of the coal; and on this point he was in thorough agreement with him. The screening of the coal would not be necessitated if there were an absence of a large amount of dust. Although the Dessau people thought it was unnecessary, he, knowing the nature of the coal he had to deal with, put the screen in; and he was very glad he did so. Because it was put in the roof, it did not necessarily raise the house 5 feet; so that there was really no great expense in this direction. It was found to be a dusty business; but he pointed out that the charging feed of the retorts contained a division plate, so that the actual division of the coal was maintained until it got into the retort. Mr. Broadhead seemed surprised at the measuring chamber being introduced; but this was a very small matter. It was a moveable plate, which only cost a few shillings. He did not claim the idea of feeding the charge as being novel. It was certainly not difficult when the man had his hand on the door of the charging shoot, because as soon as he felt that the coal was touching the bottom he shut off his coal. Their average charge worked out at between 9½d. and 9¾d. per cwt. in each retort. With regard to the letter which had been received from Mr. Körting, on the sulphur question [see next page], he would point out that the sulphur content of the unpurified gas was just about half with verticals what it was with horizontals, being 18 grains with the vertical and 35 grains with the horizontal.

Mr. LEATHER, in replying, said he would confine himself to answering questions. Mr. Allen's question with regard to the cost of the plant had to some extent been answered by Mr. Moon. The retort-house at Burnley was not at all on the lines of the Manchester one, which was really built for the purpose. The retort-house was erected before it was decided to put in vertical retorts, and was therefore of a much more substantial nature. If the retort-house was filled with retorts, the total cost of the whole, including coal-stores and coal-handling plant for storing the coal and taking it out of the stores, would come a little under the £180 mentioned by Mr. Newbigging. If the retort-house had been built after the style of the Droylsden house, specially for vertical retorts, the figures would have been much less, and might come to £140 per ton of coal carbonized per day. In answer to Mr. Allen, he must be excused if he could not give any definite figures with regard to wages. He did not think they would get down as low as was claimed by Mr. Newbigging for Manchester; but, at any rate, there was a saving, and there would be a very considerable saving doubtless on other systems, so far as his experience went. Another remark that was made was that they ought to have the results of a full period of working. Although he had not given any definite results with regard to Burnley, he had given some figures dealing with Lausanne. Mr. Moon's figures with regard to Lausanne included periods when the plant was not being worked to the best advantage. There were times when they were told that they had too much gas, and that they must make less.

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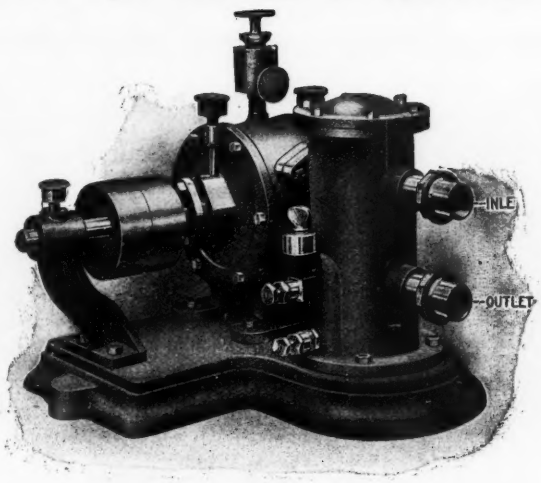

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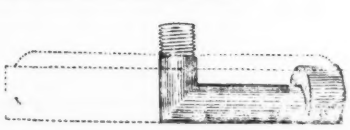

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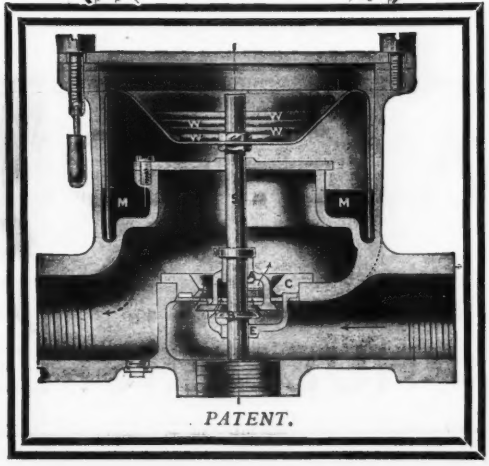

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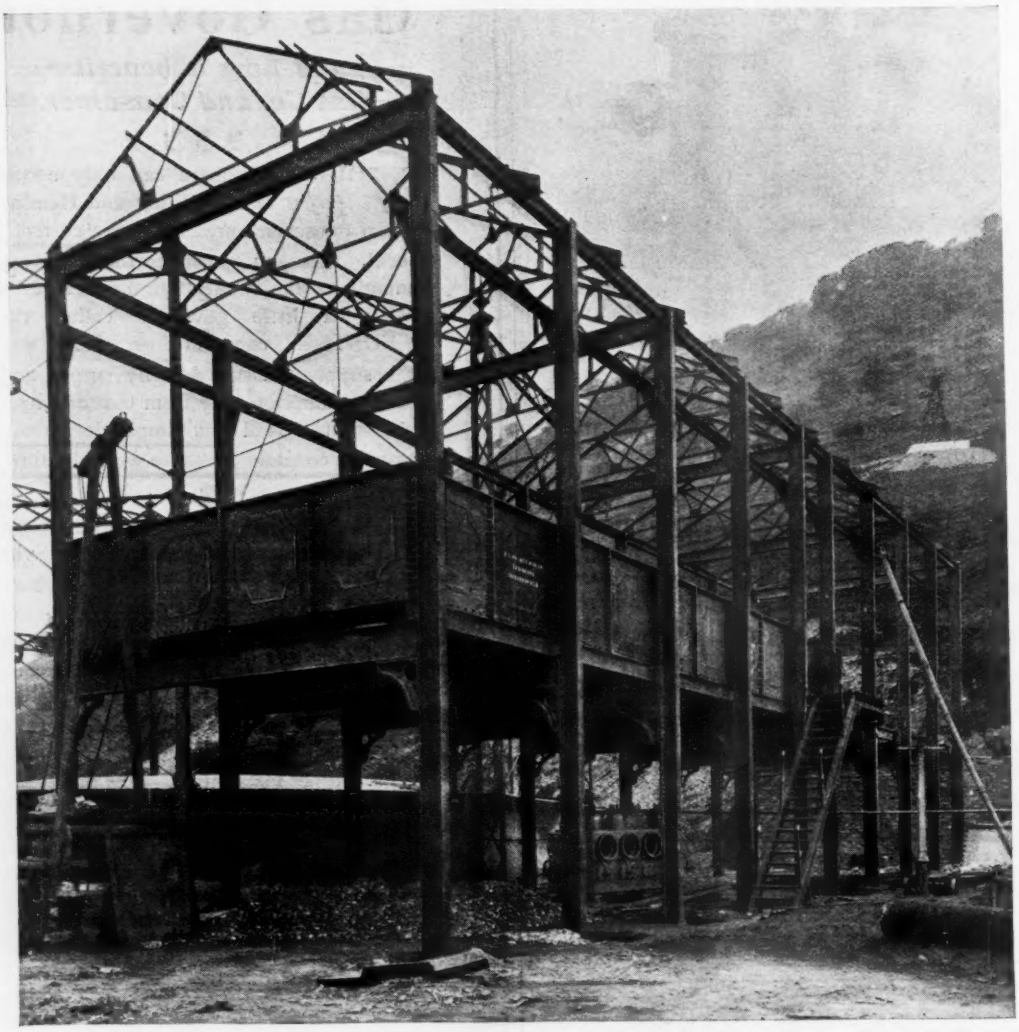

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Therefore, the retort-houses were slowed-down to manufacture less gas; whereas at other times they were pushing them to make more. These retorts had been working since the installation was started for the town of Lausanne. He was not concerned with defending the title of any paper; but in regard to the difference between continuous and intermittent carbonization, he should like to say that there was a difference in spite of the repetition, he thought, by Mr. Bell of what was stated by Mr. Körting a few years ago, when he said that it made no difference whether the coal was brought to the heat or the heat to the coal. In his opinion, it did make a difference. It would be seen at once that the coal coming into the retort took time, whatever the system employed was, to reach the temperature it finally attained. During this time, in the first stages it was at a low temperature, and was giving off gas at a low temperature. This, in the case of continuous carbonization, was entirely in the upper portions of the retort, and this gas went off without getting any colder. In the case of the intermittent retort, the coal in the centre was cold, and was a considerable time before it attained its final temperature, when it began to rise in temperature and to give off gas that was as hot. Thus there was a very great difference between bringing the heat to the coal and the coal to the heat; and this must have relation to the chemical character, as well as to the quantity of hydrocarbons in the resulting gas. He was not able to back up his opinion with the amount of figures that he had hoped twelve months ago to have done. As regards the analysis of gas, he intended to give very considerable figures; and when they were capable of being produced, he thought they would show that there was a distinct difference between intermittent and continuous carbonization, even though they might both be conducted in full retorts. There were one or two statements given in the other papers that he might add to his own—for instance, the temperature of the retorts. The temperature in the combustion chamber round the retort in the upper portion near the top of it was from 1200° C., gradually reducing and getting down to 960° near the bottom of the carbonizing space. This was the temperature immediately round the retort. These figures were very little varied from both at Burnley and Lausanne. Some remarks had been made with regard to scurfing—a subject he had not referred to. His retort sometimes went as much as 13 weeks without scurfing. At Lausanne, the average was six to seven weeks.

Mr. NEWBIGGING in reply, said it was rather hard on the authors of the papers that they should be so limited in time in replying to the discussion, particularly when those who had been criticizing the papers had so much licence. Before referring to the criticisms raised on his own paper, he had wished to offer some remarks on Mr. Holmes Hunt's valuable contribution; but having regard to the shortness of time at his disposal, he must abandon this. In the first place, they were very much obliged to Mr. Allen for his humorous and supplementary remarks. Both that gentleman and Dr. Davidson had twitted him with being a supporter of high-quality gas.

Mr. ALLEN said he certainly did not intend to do anything of the kind.

Mr. NEWBIGGING, continuing, said at any rate he could claim not to be cameleon-like, and to have changed his opinions as Mr. Allen had done. He had always been consistent in the matter.

Mr. ALLEN retorted that he certainly did not intend to refer to Mr. Newbigging as being an advocate for high standard gas; and having made this statement, he thought the matter might be at an end.

Mr. NEWBIGGING wished to add that, so far as his advocacy of high standard gas was concerned, he had never disagreed with the principle that, if the power was reduced and the selling price lowered in proportion, this should hold good. In the first place, objection had been taken to the title of his paper: "The Scientific Carbonization of Coal." They were continually twitted with being unscientific, and were called "gas men." They spent a great deal of money in their profession, though he did not think they had raised sufficient to establish a Chair in the University of Leeds to put themselves on a proper basis with regard to gas matters. They had a Committee sitting on the subject of refractory materials, getting this question put on a proper basis, and on other matters; and he thought that as long as a system which had a real claim to be called scientific could produce equal results to the present unscientific systems, they should adopt the title. If he were asking them to adopt a scientific system which put an extra cost of 2d. or 3d. per 1000 cubic feet on the gas, then he would admit that his contention had failed. Nearly the whole of the criticisms had been directed to his own paper; and he took this as a very high compliment to the system he had advocated. In his opinion, it showed the strength of the system, for the others must be very much weaker if nothing could be found to criticize. Mr. Allen had also spoken about the pollution of the atmosphere as a matter of not very great importance.

Mr. ALLEN said he did not mention that.

Mr. NEWBIGGING said Mr. Allen had stated that he had adopted some means for preventing the pollution of the atmosphere.

Mr. ALLEN replied that he did not say the pollution of the atmosphere was of no importance, but merely indicated a method by which the discharge of coke could be dealt with.

Mr. NEWBIGGING, passing on to the question of cost, said the installation which he took was one dealing with 100 tons a day. This included the whole of the retort-house, the foundations, drainage, benches, and ironwork, stoking machinery, coke-conveyors, elevators, coal-hoppers, and the necessary power plant outside; and this, he thought, was supported by figures given on the Sunderland installation, which came out to about £140. In his experience, this was about the cost. All he could say with regard to Mr. Allen's £100 per ton of coal was that in that case he had not such a substantial installation as the one costing £140. Dr. Davidson spoke about the working results. He claimed that his system would get nearer the result than any other. In the particular test he made with the Derbyshire gas coal, when the cover was open the coke came down and caused a slight explosion, so that they had to inject a little steam to the top of the coal chamber. This, no doubt, would add to the bulk of the gas; and that was the reason why the figure approached so nearly 100 per cent. It had been remarked that these were isolated tests; but that was not the case. It was simply an observation over a period. They could not give the whole working results over the period during which the installation had been at work, because they were largely of an experimental character. They had been trying all kinds of coal. He might say that Longton, Scarborough, and other places where they made such a large quantity of gas per ton of coal, must look to their laurels, because Droylsden had entered into competition with them; and he hoped at the end of the year they would be at the top of the tree.

The PRESIDENT said he was sure they were all very sorry that the time had been too limited to allow the gentlemen who had favoured them with the papers a sufficient opportunity to reply fully to the discussions; but if there were any points that they had missed, the Secretary would see that they were added to their replies in the proceedings. In this connection he would like to communicate the contents of a letter received from Mr. Körting, of Berlin—

To the President
of the Institution of Gas Engineers.

Dear Sir,—Being through the kindness of an English friend in possession of an advance copy of Mr. Dru Drury's instructive paper on Dessau verticals, and being, to my great regret, unable to take part in the discussion of it myself, I beg to offer you some remarks in writing, which if this is in agreement with the customs of the Institution, kindly have read when the paper will be discussed.

Sulphur in Purified Gas.—It is not apparent from the table that gas from verticals, if purification by lime is given up, contains only half the quantity of sulphur found in gas produced in horizontal retorts. This is an advantage proved over and over again by our daily working results and one we greatly appreciate.

Yield of Ammonia.—The increase in the production of sulphate per ton of coal has been, according to the table, 19 per cent. in Sunderland. I beg to state that we have realized a gain of 30 per cent. and more on our Berlin works.

Labour.—The new type of furnace with three rows of retorts has brought about a large diminution of labour. For three retorts, forming one unit, the charging and discharging does not require more work or time than one single retort in the old setting. In consequence, two men, one at the top and one at the bottom, can do the three retorts, equal to 1½ tons of coal, in 1½ minutes. In other words, they do work at the rate of 1 ton per minute, thus bringing the labour account to an almost insignificant figure.

Fuel.—The third row of retorts having been added without any alteration of the outside dimension of the setting, the natural consequence was a considerable reduction of the fuel requirements (about 3 per cent. by weight on the coal carbonized).

I may add that the prospects of increasing the producing

capacity of the setting, without adding to the outward dimensions, do not seem to be exhausted, and that a trial furnace is being built by which we aim at a production of 2½ million cubic feet per setting and per day.

Wishing to the Institution and to yourself a very successful meeting,

I am, &c.,

Berlin, June 9, 1911. (Signed) E. KÖRTING.

Mr. W. LANGFORD (Longton) writes, as reference had been made to the carbonizing results obtained at the Longton Gas-Works, he should like to add a few observations on the very comprehensive and valuable papers submitted to the consideration of the members. He did not know to what extent his conclusions represented those of his fellow-managers, but they were briefly as follows: In the first place, if one had to face retort-house extensions, vertical retorts should receive the most careful and favourable consideration, as this system of carbonizing promised an economy in labour per ton of coal carbonized, and, so far as could be judged, a greater quantity of ammonia, thinner tar, less naphthalene, and a saving in ground space. These were the principal advantages claimed for vertical retorts. Secondly, those who were likely to use horizontal retorts for many years to come need not fear that they would be left very far behind in general results as regarded yield of gas per ton of coal, illuminating power, and calorific value. Thus far, verticals could not beat them; and, though they were threatened, they must strive to improve on their past attainments, so as to promote a healthy rivalry between them and their "upright" colleagues, even if they had to take it lying down. The following figures would give a few of the general results obtained at the Longton works for the year ended the 31st of March: Gas made per ton of coal, 12,953 cubic feet; gas sold, ditto, 12,114 cubic feet; illuminating power (No. 2 "Metropolitan" burner), 15·82 candles; calorific value, 540 B.Th.U. From the 31st of March to the 8th of June the average was: Gas made per ton of coal, 13,071 cubic feet; illuminating power, 15·84 candles; calorific value, 538·5 B.Th.U. He gave these figures simply to show that there was still life, and also still greater possibilities, in the horizontal retort.

THE USES OF HIGH-PRESSURE GAS FOR INDUSTRIAL PURPOSES.

By E. W. SMITH, M.Sc., of Birmingham.

Although the subject of the use of high-pressure gas for industrial purposes is receiving at the present moment a considerable amount of attention, both publicly and privately, in different parts of the country, one must not overlook the fact that for some time past a few of the more progressive gas companies have been paying special attention to this subject. The author acknowledges with enthusiasm the work that has been done by them. His object in compiling the present paper is not so much to teach, as to place before the Institution a little of the experience gained in connection with the high-pressure gas laboratory recently opened by the City of Birmingham Gas Department. There has been no attempt to dogmatize. The whole subject is comparatively new, and much of the foundation has still to be built.*

The main object in experimental work on gas-heated appliances is to attain the highest efficiency. Whether it be high-pressure gas, low-pressure gas and natural draught, or air blast and low-pressure gas that is being considered, the same problems present themselves and the same conditions have to be satisfied. Gas-furnaces may be divided into two types:

1.—Those in which low temperature soaking heats are required—such as some types of muffle work, in which it is a disadvantage to have a large supply of primary air.

2.—Those in which high temperatures or large quantities of heat are required—such as in annealing or crucible furnaces, in which it is necessary to have the largest supply possible of primary air efficiently mixed with the gas before combustion.

Of the first type, it is sufficient to say that it is a simple thing with high-pressure gas, natural draught or air blast, to attain the requisite conditions with a high degree of efficiency in a properly-designed furnace, although with high-pressure gas more even results are possible.

In the second class of heating appliances, where high temperatures or large quantities of heat are required, air blast and low-pressure gas and high-pressure gas have a much wider range of manipulation than natural draught. If it were possible with low-pressure gas to obtain, by injection, a perfect mixture with slightly more than the theoretical volume of air for complete combustion without using air blast, then all the advantages of air blast and high-pressure gas would be supplied without the use of either of them. So far this has not been done on a commercial scale.

Air-blast furnaces depend either on the well-known blow-pipe effect or on the system being developed by Dr. Bone and his co-workers, termed by them "surface combustion." The disadvantage of furnaces heated by low-pressure gas and air blast is that the efficiency depends on the two pressures remaining constant. Experience shows that, under working conditions, it is too much to expect that these will remain constant; but the main defect in air-blast burners up to quite recently has been that they were badly designed—their mixing arrangements being inadequate. Such gas-burners as those recently designed which do away with secondary air and improve the mixing of the air and gas are a great advance on previous designs.

In taking up the subject of high-pressure gas furnace heating, it was first necessary to devise a satisfactory furnace burner. After making a close study of other already existent burners, it was found that they all suffered from the same defect. All high-pressure burners depend for their air on injection. An increase of gas pressure should inject a relatively larger amount of air through the burner. Where the gas injector plays into a tube, or expansion chamber as it is called, it was observed that an increase in gas pressure did not cause a corresponding relative increase in the volume of air injected. This was due to the increased expansion of the gas in the expansion tube owing to its expanding from a higher pressure. It was decided to do away with the expansion-chamber and play the jet into a correctly shaped and dimensioned conical hole, which should be part of the burner.

After much experiment, the diameter of the narrowest part of the cone was determined for various consumptions; and to aid the flow of the gas and promote the best mixing the angle of the cone was found to be 60°. The tube holding the jet was then made adjustable—moving towards or away from the cone—in order that the volume of air carried into the furnace could be regulated. Experiments show that much more than the theoretical quantity of air can be injected. The construction of the furnace burner can be seen from fig. 1.

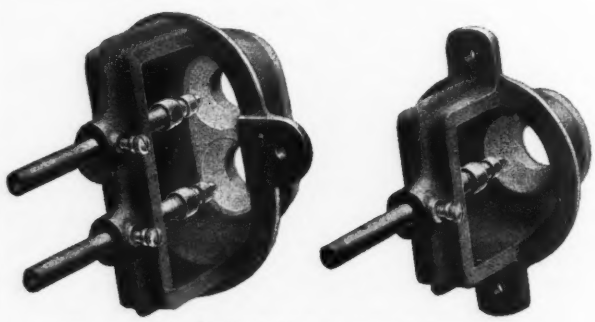

Fig. 1—Duplex and Single High-Pressure Furnace Burners.

It was next found that, although the efficiencies in furnace heating depended largely on the burner used, they also depended on the arrangement of the burners—on the cubic capacity and design of the combustion space—viz., the space in which combustion should be completed, and on the nature of the refractory materials used. The amount of combustion space varies with the specific heat of the metal to be melted and the temperature to be attained.

As an example, it may be noted that when brass is melted in a 60-lb. graphite crucible resting on a 3-inch stand in a cylindrical furnace, the space between the top of the sides of the crucible and the sides of the furnace should not be more than ¾ inch.

In no high-pressure furnace is there any appearance of flame, either at the burner or in the furnace itself, after the furnace has once been started. Combustion takes place over the sides of the furnace and the crucible—if a crucible

* In connection with this paper, reference may be directed to the illustrated article describing the laboratory referred to, as appearing in the "JOURNAL" for Jan. 31 last, pp. 287-90.—ED. J.G.L.

is being used. The whole is highly incandescent, and the intervening space is quite clear. In large oven furnaces used for annealing and hardening, where the combustion space is not confined, the same effect occurs. When looking into a large oven internally heated, in which 300 cubic feet of gas are being burnt, there is no appearance of flame.

A typical high-pressure furnace containing a single burner may be seen in plan and in section in figs. 2 and 3. The gas and air enter the furnace tangentially, and circle round the pot. The same principle holds good in other types of furnaces. The usual practice is to use one or more double-jet burners, in order that, when it is necessary to reduce the gas consumption in the furnace, one or more of the jets may be turned off rather than partially reducing the consumption from any of the jets and by reducing the pressure at the jet and reducing the efficiency of the furnace.

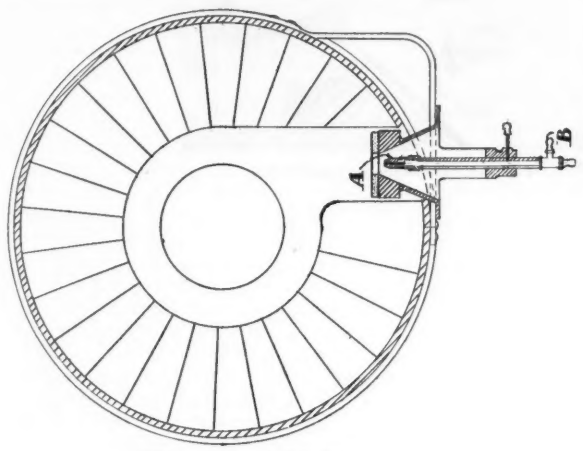

Fig. 2—Horizontal Section.

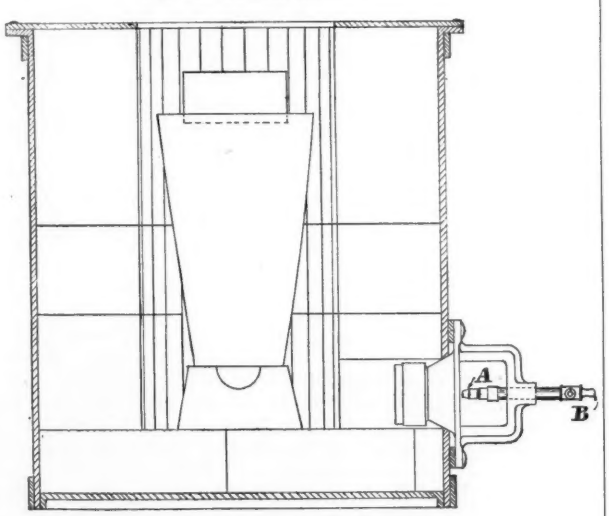

Fig. 3—Vertical Section.

Typical High-Pressure Gas-Furnace, Showing Single Burner.

The newer furnaces are being built with a double circular lining, consisting of the best standard sized arch fire-bricks, in order that, when the inner one is no longer fit for use and past repair, it may be quickly replaced by another. The second lining outside the inner one acts as a base to which to build it. New furnaces are also supplied with false bottoms, simply held, which may drop out when relining or in case of a spill due to a broken pot.

All metals with melting points up to 1400° C. are being melted on a commercial scale; and the cost of doing so compares very favourably in by far the majority of cases with coke-heated furnaces if only in fuel alone.

Then high-pressure gas-heated furnaces have so many other advantages that an all-round saving is assured. In brass-melting, the loss of zinc is only 75 per cent. of the loss in coke-heated furnaces. Loss by oxidation in the furnace in melting copper is altogether done away with, the atmosphere in the furnace being a reducing one. The number of heats to be obtained from the pots is increased; and in case of a spill into the furnace, there is less difficulty in dealing with the spilt metal than is the case when the metal falls among coke. There is less wear and tear of the pots; and heats can be regulated to a nicety.

Gas crucible furnaces should preferably be run on the foundry system; there being one "melter" to attend to a number of furnaces (at least six) and "pourers" for casting. Muffles and ovens are specially adaptable to high-pressure gas heating when correctly designed. Experience shows that where, in many cases, muffles had previously been used for annealing of all kinds, open ovens may be more efficiently employed when high-pressure gas is used.

The thinnest brass stampings leave the oven without any signs of "burning," as oxidation is termed; and the rate of annealing is from three to six times as fast as in coke-heated muffles for the same fuel cost. Tube-brazing furnaces, both for steel and brass, are entirely successful; evenness of results being again an advantage.

Another field in which high-pressure gas has not only an advantage over low-pressure gas, but in many cases over coal and coke, is in the heating of liquids. Their very nature requires that they shall be heated in metal vessels. The usual type of high-pressure furnace is no longer possible; and here advantage has to be taken of a type of ring burner. The usual low-pressure ring-burner is of no use. Not only is the jet too big, but the primary air inlet is too large, and the burner tube must be reduced to keep up the velocity of the gas and air in the burner.

Although at the Birmingham Laboratory an improvement was expected in the difference in the efficiency of a high-pressure flame playing on a metal pot containing a liquid to be heated, over the low-pressure flame, the results obtained were surprisingly high. The following is a report on an experiment carried out in this connection:—

COMPARATIVE TESTS ON HEATING BY MEANS OF RING-BURNERS WITH HIGH-PRESSURE GAS AT 7½ LBS. PER SQUARE INCH AND LOW-PRESSURE GAS AT 25-10THS INCHES OF WATER.

Particulars of Test.—A standard ring-burner was taken having a nipple of 0·07 inch diameter, and taking about 9½ cubic feet per hour at a pressure of 25-10ths inches water. This was fitted with a Keith's injector, having a nipple 0·026 inch diameter, for use with gas at 15 inches of mercury. Parallel tests were made: (*a*) With gas at 25-10ths inches water pressure; (*b*) With gas at 15 inches mercury pressure. In each case an iron pot, containing 1 litre of water, was placed over the burner at a height which gave the most satisfactory results. The time required to raise the water to 100° C. was noted in each case, and hence a relative efficiency was obtained.

Test 1.—With gas at 15 inches mercury.

Time required to raise 1 litre of water from 15° C. to 100° C.	3 min. 30 sec.
Diameter of jet	·026 inch.
Pressure	15 inches mercury = 204 inches water.
Consumption	11·4 to 11·6 cubic feet per hour.
Total gas used	$\frac{11{\cdot}5 \times 3{\cdot}5}{60} = 0{\cdot}67$ cubic foot.
Net calorific value of gas. . . .	542 B.Th.U. per c. ft.
Total B.Th.U. added	$0{\cdot}67 \times 542$
Kg. calories added	$0{\cdot}67 \times 542 \times {\cdot}252$C.
Useful kg. cals. obtained . . .	T° C. rise × kilos of water. = 85 C.
Thermal efficiency of heater . .	$\frac{85 \times 100}{0{\cdot}67 \times 542 \times 0{\cdot}252}$ per cent.

= 92 per cent.

Test 2.—With gas at 25/10 inch water.

Time required to raise 1 litre of water from 12° C. to 99° C.	8 min. 30 sec.
Consumption of gas	9·5 cubic feet/hour.
Total gas used . .	$\frac{8{\cdot}5 \times 9{\cdot}5}{60}$ cubic feet = 1·34 cubic feet.
Net calorific value of gas . . .	542 B.Th.U. per c. foot.
Total B.Th.U. added	$1{\cdot}34 \times 542$
Total calories added	$1{\cdot}34 \times 542 \times 0{\cdot}252$ C.
Useful calories obtained . . .	T° C. rise × kilos of water. = 87 C.
Thermal efficiency of heater .	$\frac{87 \times 100 \text{ per cent.}}{1{\cdot}34 \times 542 \times {\cdot}252}$

= 47·5 per cent.

It would not be difficult to subtend a list of metals with their cost of melting and the time taken; but believing that

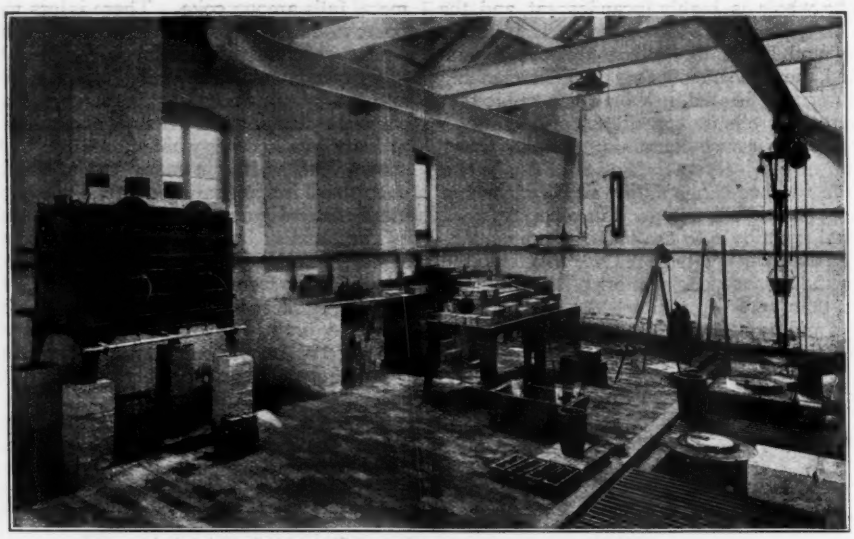

Fig. 4—High-Pressure Gas-Foundry at the Windsor Street (Birmingham) Gas-Works.

such a list would only be misleading, the writer refrains from doing so. He has come to this opinion from a wide experience—though not a long one—with metal casters in Birmingham. So much depends on the state the metal is in, both as to cleanliness and bulk and the purposes for which it is required.

The policy adopted with the consumer is to demonstrate the process in which he is specially interested—quote him the cost the process can be run at, and, after seeing his works, estimate what he should be able to do the work for. If there is any difficulty about the matter, the consumer is invited to bring half-a-ton or so of his stampings which are to be annealed—or a similar weight of his metal to be melted—with his own workmen, to the new Windsor Street foundry of the high-pressure laboratory; and he can then run a series of tests under his own conditions extending over one or two days. This has been found to work very well.

Windsor Street Foundry.—A photograph of the Windsor Street foundry is appended (fig. 4). It consists of a large room 40 ft. by 20 ft. top and side lighted. There is an overhead traveller for unloading and moving large furnaces. Nine 16-feet chimneys have been put in instead of one large one. The whole is lighted by means of high-pressure gas. There are more or less permanently installed in the foundry, three crucible furnaces—500-lb., 160-lb., and 60-lb. respectively—a twin muffle furnace, a tube-brazing furnace, blow pipes, and a small furnace for expanding the ends of 5-inch steel tubes.

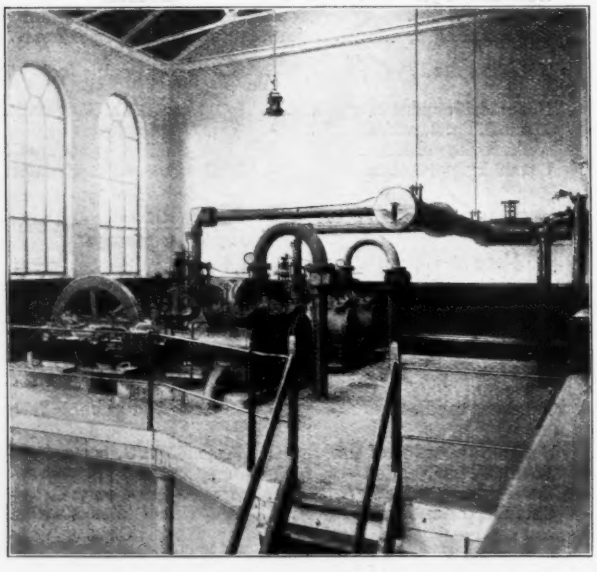

Fig. 5—Compressor House at Windsor Street (Birmingham) Gas-Works.

Windsor Street Compressors.—A general view of the compressors is shown in fig. 5. The compressors were made by the Worthington Pump Company of America. They each deliver 60,000 cubic feet an hour, and are worked at a maximum pressure of 15 lbs. to the square inch. This pressure is governed-down for individual consumers to the pressures required, which varies between 7 lbs. and 12 lbs. to the square inch, depending on the temperature to be attained. The compressors are efficiently governed to give a constant pressure on the outlet.

In areas where there are no high-pressure mains available consumers who apply for high-pressure gas are recommended to instal suitable compressors of their own. Where there is available power to drive them from steam or gas driven shafting, the outside cost for compression is not more than 2d. per 1000 cubic feet—this figure including maintenance, power, and interest on capital outlay. In recommending the type of compressor that should be used, so many things have to be taken into account that, where expenditure has to be kept down, it is sometimes difficult to advise. There are two types of compressors—the rotary and the "reciprocating."

The Rotary Compressor.—In most cases where the requisite pressure does not exceed (say) 6 lbs. to the square inch, a rotary type of compressor might be installed—especially for small consumptions working at a low pressure. Where higher pressures than this are required, a reciprocating compressor should be used, as from the results of a long series of tests with both types, it appears that the rotary is quite unsuited for pressures exceeding 7 lbs., owing to its efficiency being so reduced by the increased "slip" which occurs at higher pressures. If the term "slip" be looked upon as the leakage of gas or air past the blades of a rotary compressor, the reason for the decrease in efficiency when compressing gas to higher pressures than 6 lbs. will be more apparent.

If the volume discharge of a gas passing through an aperture at a given pressure is approximately inversely proportionate to the square root of its density, then the "slip" is considerably greater in a gas-compressor than in an air-compressor, assuming the working pressure to be the same in each case. If the density of the gas be taken as 0·45 as compared with air, the amount of slip in the former case would be about 50 per cent. more than in the latter case. In actual working, however, the slip factor determines to a large extent the critical pressure that can be maintained for a known discharge.

The actual effect of this increased slip is to bring down the critical pressure, and, consequently, higher pressures can only be attained by means of increased speed of working and increased contact friction between the rotor case and the rotor. This necessitates water cooling and a better system of lubrication. There are also mechanical difficulties which occur in rotaries when an attempt is made to obtain high pressures from them. Wherever possible, bearings should be capped in, in order to eliminate stuffing boxes as much as possible. Where stuffing boxes are used, their design should ensure leakages being reduced to a minimum. For pressures higher than 6 lbs., the author is of the opinion that the rotary compressor is unsuitable. For pressures below this, certain makes of rotary compressors can be highly recommended.

The Reciprocator Type of Compressor.—This type of compressor had been found to give very good results for working pressures of 5 lbs. per square inch upwards. It is also more positive in its action than the rotary, and requires a lower speed of revolution to run it. In this type, there is an increased number of parts, and, consequently, the machine might require more careful attention. With a well-designed reciprocator having ample bearing surfaces and a well-designed system of lubrication, the extra attention required should be of no moment.

The inlet and outlet valves should preferably be of the disc type, owing to the fact that a relatively large valve opening is obtained from a small valve movement. All gas passages and parts should be designed to prevent any restriction of the gas from leaving the compressor to the point of combustion.

When a moderate size of compressor is required, a two-cylinder, single-acting reciprocator, with cylinders arranged side by side and a double-throw crank shaft—with cranks set at 180°—might be recommended in place of a single cylinder double-action of the same capacity. With this arrangement the stuffing box is eliminated, and the only leakage possible is that due to an escape past the rings. For small compressors of the reciprocator type, splash lubrication might be adopted with a covered-in crank chamber; but for large installations, some system of forced lubrication would be necessary.

When a meter is connected with the compressor, it is necessary to use some form of anti-fluctuator, either in the form of a receiver (and the larger the better) or a special anti-fluctuator. In any case, the greater the distance between the meter and the compressor the less will be the trouble at the meter due to oscillation produced by the compressor. It might also be necessary, when using an anti-fluctuator, to employ a non-return valve to prevent the anti-fluctuator being subjected to any back-pressure due to the bye-pass valve.

There is an excellent opening for a good type of small reciprocating compressor, which is reliable in its working and efficient. Various makers are experimenting along lines laid down by the Birmingham High Pressure Laboratory, and there is every likelihood that a satisfactory machine will be available. It is absolutely necessary that such a one should be produced, as it is not possible to get those requiring furnaces to adopt the high-pressure system if they cannot depend on the regular and efficient working of their compressors. Where the high-pressure main is available, the consumer is, of course, free of all such complications.

Governors.

A governor is absolutely necessary where the main pressures are higher than the consumer requires, which would be the case nine times out of ten. Then, for distribution purposes, a large amount of latitude should be allowed for variation of pressures in the mains. There is consequently a need for a good governor.

There are two chief designs of governor on the market. (1) Those of the diaphragm type; and (2) float governors. For general work, the former seems to have been adopted as being the more satisfactory and reliable; while most of the designs of the latter type for pressures of 7 lbs. to the square inch and upwards are at present only in their experimental state.

The writer is of the opinion that, for satisfactory working, a governor should satisfy, as far as possible, the following conditions: (1) It should be independent of consumptions within the range for which it is designed, and should respond immediately to an increase or decrease in consumption, and maintain a constant outlet pressure. (2) It should have as few working parts as possible, as a large number of working parts is attended by an increase in the inertia forces, and may give rise to serious oscillation. (3) There should be no external leakages. (4) All working parts, including levers, valves, &c., should be accessible. (5) The building-up effect on the outlet when the consumption is at zero should be as low as possible. (6) The governor should give a constant pressure at the outlet whatever the pressure is at the inlet with its range.

A large number of tests have been carried out at the high-pressure laboratory on various makes of governors of the diaphragm type. The foregoing conditions and the following comments are deduced from these. So far, a really satisfactory high-pressure governor has not been met with, very few of the above conditions being satisfied. Most tests showed conclusively that a big drop in pressure occurred for a comparatively small increase in gas consumption. The diaphragm should be impermeable to gas, and as large as possible. A dead-weight load appears to be more satisfactory than any other method of regulating. The external leakages through the diaphragm have in many cases been considerably reduced by making use of specially-prepared leather diaphragms—in many cases the diaphragm itself being lined with (say) gold beaters' skin.

Sufficient care is not paid to the proper jointing between the two halves of the outer case of the governor. This in most cases has been made by means of the diaphragm itself acting as a joint ring. This is a bad practice, as it leads to serious leakages round the joint, owing to the unsuitability of leather as a jointing material. Wherever possible, the diaphragm should be so arranged as to be independent of the joint. A suitable jointing material could then be used for the external joint. The movement of the valve should be as small as possible for sensitive governing. For this reason, a flat-faced valve seems to give better results than those of the cone and needle-valve type, owing to the area of the valve opening being considerable for a small movement of the diaphragm. Where a needle valve is used, the valve stem should have adequate bearing surface in order to ensure its coming down truly on its seat. When connecting up governors, their inefficiency is frequently accentuated owing to the wire-drawing of the gas at the inlet or the outlet, due to the use of cocks having insufficient area of gas-way. Such practice always leads to trouble.

With reference to governors of the float type little need be said, as they are still in the experimental stage. From tests made at the Birmingham Laboratory, it appears that the oscillation due to the surging of the mercury is the chief defect.

The following typical test and report on a high-pressure governor may be of interest.

Test on Quarter-Inch High-Pressure Gas-Governor.

The governor was of the diaphragm type, arranged with a spring tension adjustment on the upper surface of the diaphragm. On testing the governor for pressure tightness, it was found that a considerable internal leak existed between the base chamber and the diaphragm; this being perceptible at the end of the small waste-gas tube connected to the upper chamber, where a flame about 9 inches in length was burning with a luminous flame, the outlet pressure then being about 100 inches water. Further, a somewhat serious external leak was found to exist between the diaphragm and the outer cast-iron case. It was found necessary to remake this joint before a satisfactory test could be made.

The following tests were made: (1) The diaphragm spring was adjusted to give the lowest possible outlet pressure, and a test was then made with a constant pressure of 14 inches of mercury on the inlet, with consumptions on the outlet ranging from 40 to 200 cubic feet per hour; the outlet pressure being observed in each case. (2) A test similar to (1) was made with the diaphragm spring adjusted to give a higher range of outlet pressures; the outlet pressure for each consumption being observed as before. (3) A test was then made with the object of determining the effect of a variation in the inlet pressure on the outlet pressure with a constant consumption.

Results of Tests.

	Inlet Pressure. Inches. Water.	Outlet Pressure. Inches. Water.	Consumption Corrected to 20-10ths inches Water. Cubic Feet.
Test (1)	190	79·0	40·5
	190	79·0	81·0
	190	73·0	93·5
	190	73·0	110·0
	190	71·5	119·0
	190	70·0	139·0
	190	72·0	141·0
	190	68·0	159·0
	190	64·0	200·5
Test (2)	190	116·0	49·5
	190	113·5	98·0
	190	117·5	81·0
	190	113 5	128 5
	190	107·0	172·0
	190	103·0	206·5
Test (3)	195	118·0	99·5
	163	117·0	99·0
	136	116·0	98·5
	122	111·0	91·5

Summary of Results.—From tests (1) and (2), it will be noted that in (1) For an increase in consumption of 160

cubic feet per hour, from 40·5 cubic feet to 200·5 cubic feet, the total drop on the outlet amounted to 15 inches of water. (2) For an increase in consumption of 157 cubic feet an hour, from 49·5 to 206·5 cubic feet, the total drop amounted to 13 inches of water. The governor was found to work moderately well up to consumptions of about 150 cubic feet per hour; the drop being considerable when the consumption was further increased.

Notes as to Mechanical Construction.—The main joint was found to be a source of constant trouble, owing to the leakages taking place at this point. This trouble is mainly due to the fact that the diaphragm is used to form a joint ring. The gas volumes were determined by the "pressure jet" method, as explained in another part of this paper.

High-Pressure Service and Supply Fittings.

In Birmingham, high-pressure services are of steam-piping—this being heavier and less porous at the lateral joints than gas-piping. Owing to the bearing space on the threads being so small, where taper threads are used in conjunction with parallel threads in the socket, it is found better—in fact, necessary—to employ parallel threads throughout. The bearing space is thereby very much increased, and tightness of joints will depend very much less on the packing, which is sure to eventually give trouble. Most high-pressure gas-cocks have one defect in common. The way-through is almost invariably reduced from the full diameter of the pipe. The gas is consequently wire-drawn, and the pressure at the outlet considerably reduced. Cocks should be full-way, made of gun metal, with as high a bearing surface as possible, and have inverted plugs.

The Measurement of High-Pressure Gas.

Where high-pressure gas is taken from the main, it is generally agreed that each consumer should have a governor placed before the inlet to his meter. He would then not only have a supply at constant pressure (which is absolutely necessary in all heating processes), but it to a great extent solves the mechanical difficulty of metering the gas. Some standard pressure should be adopted to which all volumetric measurements may be corrected back.

The writer believes that no device will be permanently satisfactory which automatically corrects the reading of the meter with changes in pressures. The possibilities of mechanical defects are too great. Where constant pressures are used, the index of the meter could be compensated so as to enable the meter to pass the gas at that constant pressure but measure it at the standard pressure. Suitable governors would have to be used so that the constancy of the pressure could be relied on.

In many cases, wet meters have been used for measuring high-pressure gas, and these have been specially designed so that the cases and the joints might be able to withstand the pressures to which they are subjected. Large cast-iron meters should be designed symmetrically, and approach as nearly as possible the spherical form. If this is done, the necessity for excessive thickness of metal will be done away with, providing that all surfaces subjected to direct thrusts are suitably webbed. In any case, the metal should be of even thickness throughout. In this way, the internal stresses are equalized. If designed in this manner, the meter will be lighter to handle and the cooling stresses when the castings are made will be minimized.

All high-pressure meters should be provided with inlet and outlet cocks interconnected. These might be worked by means of a worm wheel driven by a worm. A slight lead is given to the outlet cock; and in this way any sudden load on the meter drum is prevented. This arrangement necessitates a bye-pass tap connected across the outlet cock to relieve the meter of pressure. The use of the tap also makes it possible for the meter to be properly watered. The "Rotary" meter, depending in principle on the velocity of the gas-flow works quite efficiently when the pressure of the gas is absolutely constant at the inlet and when the meter has been standardized for this pressure.

For convenience in experimental work, it has been found necessary to find a method of determining accurately gas consumptions at varying pressures without using a meter of the orthodox type. Jets were drilled and standardized in their design. This jet is shown in fig. 7. It will be seen that it consists of a *Vena Contracta;* the depth of the jet from outlet to inlet being 0·05 inch, and its diameter varying with the immediate requirement. The gas, compressed by means of a small rotary, was measured before compression on an accurate low-pressure wet-meter.

From experiments at varying pressures—the pressures always being measured directly before the jet—the gas consumption per hour at 20-10ths (for Birmingham gas with a specific gravity of 0·45 compared with air) was determined. The results were plotted out in the form of curves; there being a different curve for each size of jet. For practical purposes—and these determinations do not take into account the usual corrections for barometric pressure and temperature generally associated with scientific research work—these curves are extremely reliable, as has been found since meters have been more generally used when constant checking was possible. Meter readings for the consumer are not corrected for temperature and pressure when taken, and consequently this method, which was adopted to take the place of meter readings, does not require correction.

One of the curves obtained in this way is shown in fig. 9. The size of the jet is 0·095 inch. A large series of curves have been obtained for various sized jets between the pressures of 5 inches and 100 inches of water. The curves are about to be extended from 100 inches water pressure to 400 inches. In the meantime, consumptions for the same sized jets at higher pressures than 100 inches water may be calculated from the formula

$$Q_x = \sqrt{\frac{P_x}{P_s}} \times Q_s$$

where

Q_x = the consumption required at pressure P_x.

Q_s = the known consumption at pressure P_s.

Once a pressure-consumption curve has been determined by actual experiment, it is a simple thing to obtain from it consumptions at higher pressures with the same jet, or consumptions either at the same or different pressures with different sized jets.

For

let d_s = the diameter of the standard jet used in experimental curve.

P_s = any pressure taken as standard from the curve.

and Q_s = consumption of standard jet of diameter d_s with a working pressure P_s.

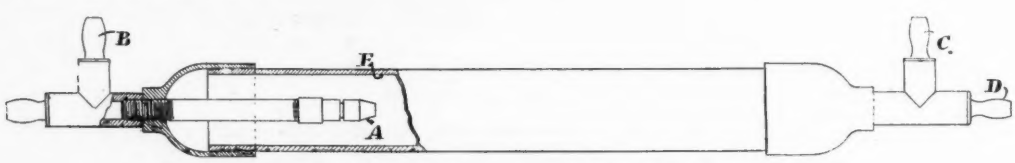

Fig. 6—Venturi Meter for Running Low-Pressure Gas to the High-Pressure Supply.

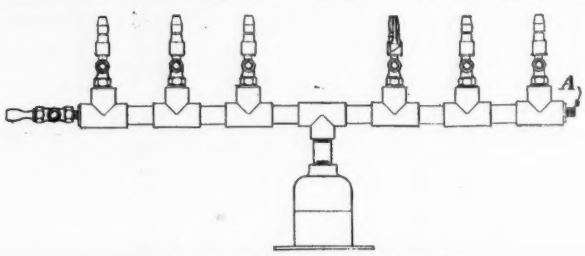

Fig. 8—Gas Consumption Test-Rail.

Fig. 7—High-Pressure Gas-Jet.

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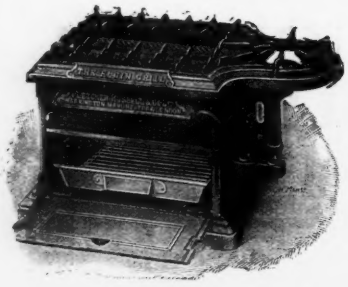

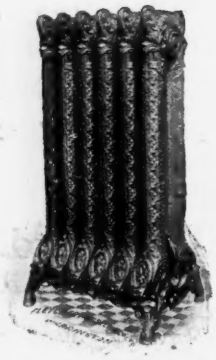

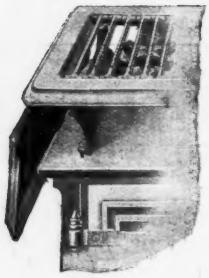

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Then, if d_x, P_x, and Q_x refer to the diameter, pressure, and consumption respectively of the required jet—

$$\frac{Q_s}{Q_x} = \frac{d^2_s}{d^2_x} \quad \text{with pressure constant} \quad \text{and}$$

$$\frac{Q_s}{Q_x} = \sqrt{\frac{P_s}{P_x}} \quad \text{with diameter constant,}$$

or where P_x and d_x are both variable

$$d_x = d_s \sqrt{\frac{Q_x}{Q_s}} \times \sqrt[4]{\frac{P_s}{P_x}}$$

This expression gives an approximation for the discharge of gas of density 0·45 through circular apertures where $1 = 0{\cdot}05\,d$, and is near enough for all practical purposes—in fact, it conforms very closely indeed with actual experiment. Other factors, such as length of jet—*i.e.*, thickness of diaphragm, coefficient of discharge, shape of jet, &c.—should be included in one's calculations; but for practical purposes it is unnecessary to include these factors, some of them being standardized in the form of jet used.

A convenient arrangement for taking consumptions in testing governors and similar appliances is that shown in fig. 8. This consists of a number of various sized jets, which can be used singly or in combination so as to pass known quantities of gas at known pressures. Pressure readings are taken at A. In the laboratory, when heating low-pressure appliances by means of gas from the high-pressure supply, an arrangement similar to that shown in fig. 6 is used.

A = high-pressure inlet of known diameter of jet.
B = T at which the pressure is taken.
C = T at which the pressure of the low-pressure supply is taken.
D = low-pressure supply.

If the consumption has to be calculated, then the pressure in E has to be allowed for.

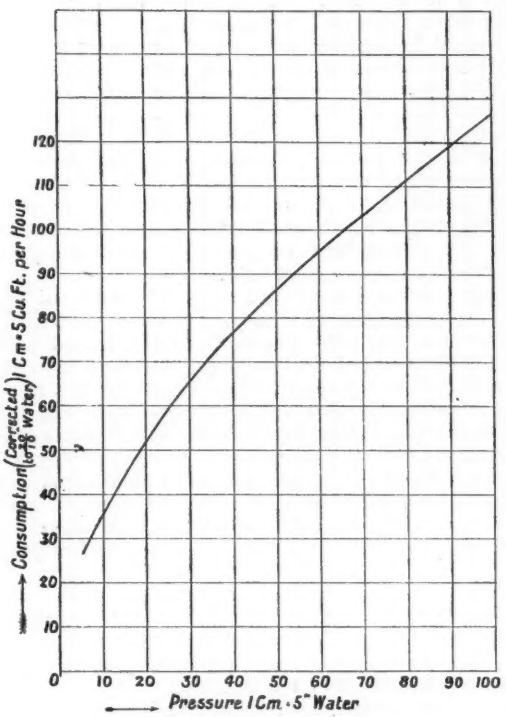

Fig. 9—Consumption Pressure Curve.

Jets, 0·05-inch thick and 0·095-inch in diameter, with Discharge to the Atmosphere.

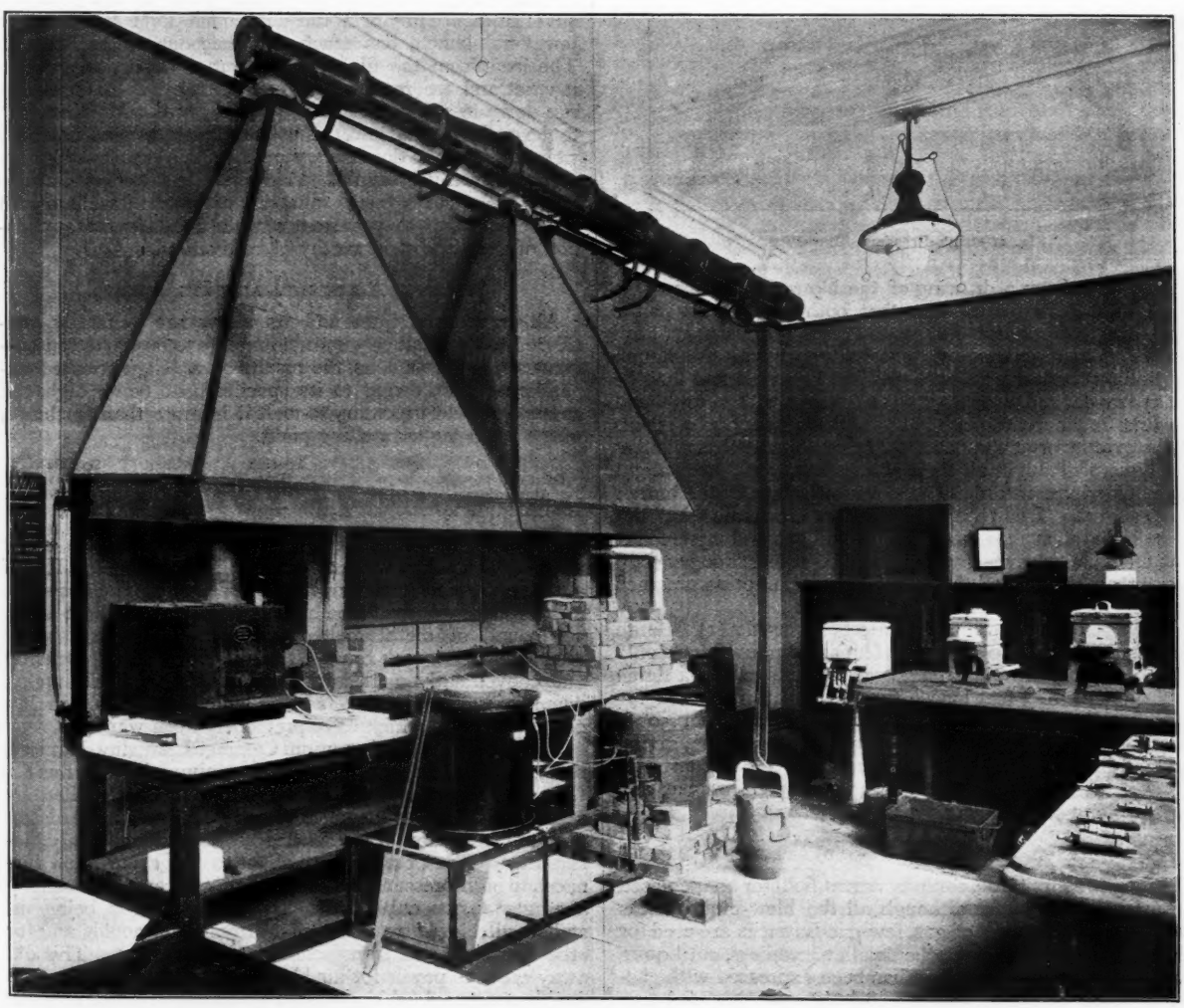

Fig. 10—Main Demonstrating Room, where Furnaces are Built to Special Designs to Show how Worked.

The High-Pressure Gas Blow-Pipe.

When it was first mooted in Birmingham that high-pressure gas might with advantage be employed industrially, users of all descriptions and sizes of blow-pipes were among the first to inquire as to the possibility of applying high-pressure gas to blow-pipe work to displace air blast, whether from foot bellows or from a compressor. Early experiments showed that gas escaping from a jet at a sufficient and definite velocity gave a stiff and non-luminous flame similar to that obtained with an air-blast blow-pipe. If the pressure was reduced, the flame gradually became luminous, and if increased the flame would leave the jet and combustion cease. This pointed to the necessity for a constant pressure as well as the use of a pilot light.

Neither of these conditions appealed to the writer, and they were discarded. A blow-pipe to be of use should be efficient under a wide range of pressures, and a flame obtained by means of a pilot light is ill-formed and uneven. The problem was partially solved when the idea occurred to try the effect of connecting a supply of high-pressure gas to both the gas and air tubes of the usual air-blast blow-pipe. The gas supply connected to the fine jet of the pipe, ordinarily the air-blast pipe, escaped as high-pressure gas—viz., at a high velocity; that connected to the usual gas-tube became expanded by passing into a wide tube, escaping round the jet for all intents and purposes as low-pressure gas.

It was found that by leaving this latter turned slightly on so that a small flame was obtained round the jet—when the high-pressure gas was turned on from the jet, this small flame acted as a concentric bye-pass or pilot light with none of the disadvantages of the orthodox form of pilot light. When the maximum stable flame had been obtained from the high-pressure jet, the low-pressure supply could be turned on and the size of the flame increased—it being non-luminous, partially luminous, or luminous, depending on the velocity of the gas coming from the high-pressure jet.

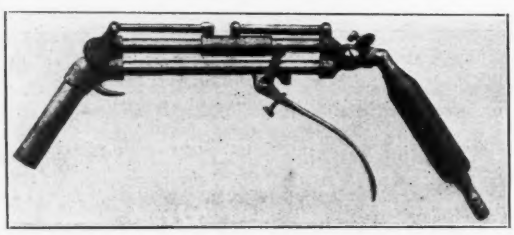

Fig. 11—High-Pressure Blow-Pipe.

Fig. 11 is from a drawing of the blow-pipe in one of its final forms. It will be seen that both movements in the pipe—the low-pressure control and the high-pressure control—may be manipulated by means of one hand—the thumb controlling the low pressure, which is less used and may be set at any desired consumption by means of a screw—and the first finger controlling the high-pressure supply by means of the grip lever at the handle. It was found that all sizes and types of flame in all their graduations would keep alight at the blow-pipe if a metal tube was fitted round the burner jet as shown. This tube not only kept the flame "in," but brought about such a good mixture of gas and injected air that the flame produced was found to be at least 100 per cent. hotter than a flame of the same gas consumption obtained from the usual type of air-blast blow-pipe.

Three sizes of the blow-pipe are being used: (1) A large one taking from 80 to 500 cubic feet an hour, used for mould drying, silver plate annealing, brazing, &c., having a flame from 9 inches to 3 feet long. (2) A smaller pipe used for large jewellers' work, having a consumption from 50 to 100 cubic feet an hour. (3) A small jewellers' pipe, giving a pencil-like flame having a consumption of from 5 to 25 cubic feet per hour. All these pipes work well at any pressure between 10 and 25 inches of mercury.

Cost of Melting Gold Alloy.

In the jewellery trade, there is a great field for an increased consumption of gas, for although all the blow-pipe work is already done by means of gas, few gas-furnaces are used for metal melting; and among the smaller jewellers, until quite recently, much dissatisfaction has been expressed with gas-heated muffles, owing to their bad design and wasteful consumption. There could not be a better field for gas-heated muffles and crucible furnaces of a small type. Their use is intermittent, and the environment in which the trade is carried on calls for a really compact and cleanly method of heating.

Those jewellers who sell their "scrap" and "lemmel," know they are losing money by doing so; and most of them would welcome a simple method of running-down the metal themselves. Those who run their own down, do so in a coke-furnace, or by means of air blast and gas. The foot and hand bellows for the latter method are still largely employed. In either case, the method is unsatisfactory, as in the coke-heated furnace the heats are so uneven that very careful attention has to be paid to them; and in the event of a pot cracking, it is much more difficult to abstract the metal from among the coke than from the bottom of the gas-furnace. It is obviously impossible to obtain even results by means of bellows blast. A well-designed low-pressure gas-furnace would do all that is required and for cheapness a furnace heated with high-pressure gas is unassailable.

A series of tests have recently been carried out in connection with the high-pressure laboratory in conjunction with a number of jewellers. One of the objects was to determine the relative costs of melting gold, in 100 oz. lots, with coke, air-blast and gas, and high-pressure gas, and then reducing it from 18 carat to 9 carat by alloying the gold in the usual way with silver, copper, and composition. Summarized the results were as follows:

	Coke.	Gas and Air Blast.	High-Pressure Gas.
Cost of gas (or coke) per melt	3d.	3d.	½d.
Weight of metal melted	100 oz.	100 oz.	100 oz.
Cost of labour	9d.	1s. 8½d.	4½d.
Time taken to melt	1 hour	1½ hours	½ hour (from cold furnace)
Total cost to melt	1s.	1s. 11½d.	5d.
Loss by over-heating	Appreciable	Nil	Nil

If the same quantity had been sent to the "rollers" to melt, the charge would have been 4s. 6d. for gold and 2s. 6d. for silver.

"Lemmel," which is the name given to the gold and silver filings caught in the suspended hide beneath the jewellers' bench, has much carbonaceous matter with it. The iron from the files is taken out of this by means of a magnet and the remainder mixed with a flux before being run-down in a furnace into the ingot. If this is "sent out" to be refined, the jeweller usually loses 10 per cent. by weight. This he does not appreciate; and he would gladly ingot his own if he could. Many do. In jewellery districts there are such a large number of small jewellers and enamellers, that they present a wide field for the application of gas; and it is worthy of cultivation.

Melting Aluminium and Its Alloys.

Although aluminium and its alloys are generally considered to be peculiarly suitable metals to be melted in gas-furnaces, it is found, as the results of a long series of experiments, that, owing to its specific heat being high, the amount of heat necessary to melt it is more than for brass, which has a higher melting point.

	Specific Heat.	Melting Point. ° C.	Specific Gravity.
Aluminium	·212	654·5	2·56
Brass	·094	900	8·4

Owing to the low specific gravity of aluminium, a pot which will hold 500 lbs. of brass will only take 140 lbs. of aluminium; and assuming the temperature to be the same in both cases—it would be higher for brass—the heat losses per pound of metal melted are greater in the case of aluminium than with brass. Aluminium is most efficiently and conveniently melted in large quantities, as the metal, when ready for pouring, may be ladled for casting in hot 20-lb. crucibles, which have previously been warmed.

The Birmingham Aluminium Castings Company, Limited, melt, on the average, 17 tons of aluminium alloys per week. Of this amount, 7 tons 10 cwt. are now being melted by means of high-pressure gas in furnaces designed by the high-pressure laboratory; the remainder being melted in coke-furnaces. The Company are about to convert all their furnaces to high-pressure gas. The daily gas consumption now averages 19,000 cubic feet. High-pressure gas being installed, all blow-pipe work for warming the moulds and for other purposes was transferred to high pressure. This did away with the power for air blast, and with the cumbersome double armoured tubing necessary in the old method.

The Company have four furnaces, each consuming, on

the average, 450 cubic feet per hour. The furnace has a loose bottom, and is heated by means of eight jets facing tangentially with the inner side of the furnace—four jets on either side. The cost of melting depends very largely on the state of trade and the nature of the castings to be poured. The smaller and finer the castings, the dearer is the cost of melting, as not only has the metal to be allowed to soak in the furnace a little longer, but the whole of the casters are engaged in work which requires little metal. The more the casting shop foreman can arrange for his casters to be waiting for metal, and so press the furnaces to their full capacity, the cheaper will be the cost of production. It is very difficult to do this, however.

The cost of melting in the new furnaces, week in and week out and including wastages, dinner hour losses—when furnaces are running at half heat and no metal is being poured—works out at 12s. a ton. On a single day's melt, under good conditions of working, this figure is halved. The average rate of melting is 100 lbs. in half an hour. The manager states that, by using high-pressure gas instead of coke, the labour costs are halved, the cost of melting is more than halved, the amount of metal melted per pot is much increased, there is less oxidation of the metal during the melt owing to the presence of a reducing atmosphere throughout the furnace, the method is much cleaner, there is no carting of ashes, there is no stoking up, heats are easily and simply controlled, and there is a more even alloy. As a result of careful tests by experts it is found that the tensile strength of the alloy is increased, there is a saving in the rebuilding of the linings when the inner one is worn out, and, lastly, the new method is much better for, and much preferred by, the furnace men.

The figures given here are actual works costs. In the Birmingham Gas Department high-pressure foundry, aluminium is being melted at as low as 6s. a ton. With gas at from 1s. 3d. to 1s. 6d. per 1000 cubic feet, there should be a great future for it for industrial use. It can be applied to all heating processes with efficiencies reaching in some cases at least 90 per cent. Its chief charm is its cleanliness and its simplicity; and in by far the majority of cases it compares well in cost with solid fuel.

Discussion.

The PRESIDENT said the members were indebted to Mr. Smith for his very valuable paper; and also to the Birmingham Corporation for the pioneer work they were doing, which would be of benefit to all gas undertakings. They ought to have credit for the information they had given the members. He hoped the discussion would be a good one, because the subject was most interesting.

Mr. J. F. BELL (Derby) said the author's remarks were specially interesting to him, because they were going in for the use of gas for brass melting; and they had pointed out the advantages there would be in the great saving in crucibles, which were costly, and also in zinc, while there would be less dross. It was very satisfactory to them as an Institution to know that the Corporation of Birmingham were able to carry on pioneer work. It was too much the habit to look to the £ *s. d.* side of the question first; and they were often not sufficiently enterprising to do the necessary experimental work. He would therefore add his congratulations to those of the President to the Gas Department of the Birmingham Corporation for being so public spirited as to undertake this pioneer work, which must not only be to their own benefit, but to that of the gas industry at large.

Mr. J. P. LEATHER (Burnley) thanked Mr. Smith for his paper, and the Birmingham Corporation for the information conveyed in it. Having regard to the shortness of time at the disposal of the members, he would not have risen had it not been that he had something to criticize. In the first place, in the early part of the paper, there was a statement which he had hardly expected from a gentleman like Mr. Smith, where he said experiments showed that much more than the theoretical quantity of air could be injected. This depended upon the theory. If they could get more air injected than theory specified, the theory must be wrong. He did not think it was possible to draw more air in by a jet than any reasonably conceived theory would admit of. He had worked out this question, and some time ago he was in correspondence with Mr. Mansfield, of Liverpool, who had been making a number of experiments on the quantity of air drawn in by a jet in burners and in tubes of that size. These experiments had been extremely interesting. At that time he had just written out a formula which was supposed to give the theoretical quantity of air that could be drawn in. He had not worked it out from the very commencement from his own ideas, but he had started with those which were published some years ago in a paper in the "JOURNAL OF GAS LIGHTING" by Mr. Scott Snell. On comparing the results with Mr. Mansfield, however, he came to the conclusion that the formula was wrong. The consequence was that he went to the back of it, and started from the beginning on an energy formula, and worked out a fresh one which gave a much higher quantity. It was worked out on the portion of air that could be drawn in by a jet of a certain size, and in relation to a tube of a particular size. He should be very glad if Mr. Smith would really compare his results with the formula he had worked out, which he would communicate to the Technical Press, so that they might see how it really compared with work carefully checked, as no doubt Mr. Smith's had been. There was one other point which he felt he must criticize, though he should not have said much about it if Mr. Smith had not emphasized it, and that was the question of surface combustion. He was one of those who did not believe in surface combustion at all—that was to say, he did not believe in the idea of high temperatures requiring a surface, as was really laid down by Professor Bone in his lecture the previous night. If there had been an opportunity for discussion after the lecture, he should certainly have joined issue with Professor Bone on the question. Of course, he knew that some of the experiments had shown the influence of surfaces in promoting combustion at low temperature; but he was referring to the question of high temperature. Mr. Smith had spoken about the narrow space round the crucible, and had referred to the fact that if one looked into it there was no flame to be seen. He noticed that Mr. Smith had said that there was no "apparent" flame; and as he supposed the author was safeguarding himself by using this expression, he would not criticize him. If they looked into the chambers where the walls were entirely white hot, they could see whatever flame there was. The question was: Did the word flame mean what could be seen, or did it mean a chemical combination going on between gas apart from solids? He understood Professor Bone's contention was that there was much fiercer combustion going on against the surface than where the surface was not. Where there was a narrow wall between the crucible and the side of the furnace, which was white hot gas, half way between these surfaces was bound to be at a higher temperature than that of the surface. Even if the surface was causing extra combustion, the temperature would be higher. He contended that there they had the combustion, and that the surface had not very much to do with it. There was one word in Mr. Smith's paper which showed that he had some idea that what he (Mr. Leather) was saying was true, because he said that the efficiency of the burner depended largely on the cubical capacity of the combustion space. They had rather been given to understand that they must do away with the cubical capacity altogether; but it was evident from Mr. Smith's experience that there must be a certain cubical capacity in order that there might be a flame.

Mr. GEORGE HELPS (Nuneaton) said he should not have risen to discuss the paper if it had not been for the unfortunate fact that he came from a county where they had had high-pressure gas produced up to 100 lbs. for the past eight or nine years. They were very pleased to learn that they had a man who was taking up high-pressure work with the ability of Mr. Smith, who was able to put before them in suitable language the important factors he found in dealing with the subject. He (Mr. Helps) had had occasion to criticize the work of the Research Committee, and had had to differ from Mr. Smith with regard to the efficiency of the burner areas of the nipple. He had argued that the injections depended absolutely on the pressure of the gas and the quantity of the gas used. The pressure was the power, and the volume of the gas was the quantity of that power. So far as his experience went, this depended absolutely on the pressure, and not on the area of the nipple This, of course, they had discovered in high-pressure distribution. Some years ago tests were made, over 3 lbs. pressure. The chief matter of criticism he had to offer dealt with the test Mr. Smith gave in his paper. He showed that with gas at 15 inches of mercury he used 0·67 cubic foot; and when he was using gas at 25-10ths of water he used 1·34 cubic feet, or a difference of 47·5 per cent. in favour of the high pressure. In his opinion, this was absolutely wrong. He had not made a similar test to the one that Mr. Smith had given them; but he intended to do so. He

would give his reason for holding the opinion he had expressed. The efficiency of the burner depended on the quantity of air which could be got to mix with the gas; and if Mr. Smith told him that it required 15 inches of mercury to get in the proper quantity of air to this gas, he could not accept it. If this were the case, let them consider what they had been doing all these years. Had they been losing 47 per cent. of the efficiency of the product that they had been supplying? He was strongly of opinion that this high-pressure business could be carried too far. He had 1500 customers, but he had not six who were using gas at high pressure. They could supply gas at 3 inches pressure, which gave them all the efficiency they wanted. They could have it at 3 inches, 14 inches, or 2 lbs. pressure, whichever they liked, and they would charge them for it. The temperature of a flame, if it were using the same quantity of gas and air, depended upon the size of it. Professor Bone showed this. If one had a boiler, and wished to get the best efficiency from it, and to find out whether or not he was getting the best efficiency, let him put on a ring burner with a pressure of 15 inches of mercury and look at the flame, and then put on 2½ inches and look at it. It depended somewhat on the gas they were using; but he would undertake to say he had a burner that would give the same flame structure that could be got with 15 inches of mercury. This was just the difference between Mr. Smith's point of view and his own. It was known that there was four-and-a-half to five times the volume of air to gas required. Mr. Smith had referred to high-pressure meters. For his part, he did not know why they wanted to go to the expense of high-pressure meters. Nine years ago, he knew a firm who took up the making of high-pressure meters, much on the same line as that adopted by the Birmingham Corporation; but they were given up because there was no use for them. The patents were taken out in a provisional form. If they wanted to use gas at 7 lbs. pressure, as Mr. Smith said they did, there might be some use for high-pressure meters; but if they only wanted to use gas at 2 lbs. pressure, there was no need for them, because any ordinary meter would enable them to register gas at 2 lbs. pressure, and the difference in the cost of the gas could be added. He thought to bring in all these things was likely to interfere with the progress of high-pressure gas. Referring to the governors, he was astounded to learn that Mr. Smith, who was only 18 miles from Nuneaton, did not know that there was a governor there doing all this work. He could show 20 or 100 burners on one governor; and if they put one burner on, the pressure was the same as with 100. The part of the paper dealing with the melting of metal might, of course, be very interesting; but he had not done much in this respect. By all manner of means let the Corporation of Birmingham have the credit they were entitled to; while at Nuneaton they hoped they would continue to get some of the results they were now getting.

The PRESIDENT said the subject of the paper was a most interesting one, and a good deal of time might be taken up in discussing it, if it were at their disposal. The members who had spoken had brought out many of the points; but before calling upon Mr. Smith to reply, he would say that in Glasgow there was considerable trouble in getting the full efficiency out of high-quality gas. There was much difficulty in obtaining the proper admixture of air. It was found in testing high-pressure gas, that the efficiency did not come up to what it should be; but as soon as they put in a little air, they could make the pressure much lower. He thought there was some little difficulty in going to too high pressure, owing to the loss that might be caused.

Mr. SMITH, in reply, dealt first with Mr. Leather's comments. He said they knew the formulæ to which he referred, some of which already existed; and he quite agreed that it was impossible to do better than a correct formula. But there were correct formulæ and correct formulæ. He did not mean to suggest in any way that Mr. Leather's was not correct, but he should like to have it.

Mr. LEATHER said the question was that more energy was got out of the burner than was put into it.

Mr. SMITH said, having regard to the reference to Mr. Mansfield, it might be sufficient comment to state that the gentleman named had seen the burner, tested it, and offered to finance it to the extent of a few thousand pounds. He did not think it was quite wise to discuss Professor Bone's lecture in his absence; consequently he would not go into the question of surface combustion so far as it concerned him. Surface combustion, as he understood it, meant flame or combustion taking place inside or on the surface of the pores of the fire-brick. Then there was the question of efficiency for heating to which Mr. Helps had just referred. There was a certain amount of radiation taking place in flames. The better the mixture of gas and air, the higher the initial temperature of combustion, and the greater the combustion radiation; and if they got a carbon monoxide flame actually in contact with the metal they were heating, they had the whole of this chemical radiation, so far as possible, in contact with the metal. It passed through the metal to its maximum degree; and he quite agreed with Mr. Helps that the larger the flame the greater its temperature. But if they could catch the chemical radiation actually before it passed the gas as heat, they would get efficiency which could not be obtained from lambent or apparently well-shaped flames. He did not think Mr. Helps could get his pressure with the flame.

Mr. HELPS said his point was that he could.

Mr. SMITH replied that if he thought Mr. Helps had tried it, he would not question it; but that gentleman had said he would try it when he returned home. With regard to high-pressure meters, they were working up to 12 lbs. for brass melting. If the paper had done no other good, it had brought forth knowledge that there was in existence a governor that would satisfy all requirements.

The PRESIDENT said they were indebted to Mr. Smith for bringing forward the matter, which had not had its full meed of discussion, but had given them a good deal of valuable information. Mr. Smith had promised to make some additions to his paper, and give some figures which they would be very pleased to receive.

PUBLIC LIGHTING.

By S. B. LANGLANDS, of Glasgow.

Last year Mr. Abady read an extremely useful and interesting paper on public lighting from a municipal point of view. To allay any fears that the same ground is going to be traversed in the present paper, the author would say at once that his intention is to speak more on the administration of a public lighting department, with the work at Glasgow as a basis. One reason for taking this course is that there is a constant request from different directions for information as to the method of carrying out the work at Glasgow.

The lighting of the city is carried out under the terms of the Glasgow Police Act of 1866; and the author would make special mention of the date of the Act, as this largely explains why there are still some flat-flame burners in use in private streets and courts and common stairs in the city. The powers possessed under the Act entitle the Lighting Department to recover only 15s. per lamp per annum, which sum is totally inadequate to meet the cost of incandescent lighting. The flat-flame burners are now, however, being gradually displaced by a small swan-neck incandescent gas burner, which costs no more per annum to maintain than the 2 cubic feet flat-flame burner which has been in use for so many years. The only stipulation made before installing this burner is that a square lantern of our standard pattern must be provided by the proprietors to take the place of the old globular type.

The rat-tail burners on stairs are also being rapidly done away with. The difficulty which had to be met with here was that the figure of 8s. per jet per annum, which the Act allowed was insufficient; and a mutual agreement between proprietors and the Corporation, as an evasion of the Act, had to be arrived at to allow incandescent burners to be installed at a slightly higher rate than the statutory charge. The burner used is the "Glasgow" inverted burner—the invention of Mr. Alexander Wilson.

The Watching and Lighting Committee, and more particularly a Sub-Committee drawn from the parent Committee, are responsible for the lighting of every public and private street, court, alley, or wynd, which is open and accessible to the public, and every common stair. A few figures showing the extent and methods of lighting may be of interest. There are 873 electric lamps in the city (787 10-ampere arc lamps and 50 7½-ampere, 36 Osram incandescent electric lamps), and 16,740 incandescent gas-lamps in public streets. In the private, or, to use the English term, unadopted streets and courts, there are 2287 incandescent gas-burners and 3524 flat-flame burners. In the closes and the common stairs throughout the city's tenements, there are 19,763 incandescent gas-burners, 2178 electric incandescent stair-lights, and 45,045 rat-tail jet gas-burners.

Gas and electricity are not purchased by the Glasgow Corporation Lighting Department in an exactly similar manner as yet. The Watching and Lighting Committee buy annually from the Gas Department about 425 million cubic feet of gas—making the best possible use of it by adopting the style of lamp, type of burner, &c., considered most efficient. The Electricity Department, on the other hand, supply light—that is, they charge £12 per annum for a 10-ampere arc lamp and £10 per annum for a 7½-ampere lamp. These charges include switching on and off, cleaning and trimming. The author would direct attention to the particularly cheap rate at which electric lighting is supplied in Glasgow, so that members may understand how acute the competition between gas and electricity is. The charge for gas for public lighting is at the rate of 1s. 8d. per 1000 cubic feet. At present, the Electricity Department have been asked to change all the existing type of arc lamps into 8-ampere and 10-ampere flame arc lamps; and this they are agreeable to do at a capital cost to themselves of between £9000 and £10,000, on the one condition that no rebate on the present charges is asked for for nine years.

It will readily be seen what a good bargain this is for the Lighting Department when the present annual rates charged per lamp are considered. The Gas Department have at the same time been asked to erect fifty high-pressure gas-lamps, which will remain under the care of the Gas Department for a year or two, till sufficient comparative data have been obtained to allow the relative merits of the two systems of lighting to be judged. Both departments will then be supplying light at a certain cost.

The streets chosen for the test of high-pressure gas lighting are important ones—one of them running parallel to a street lit with electric flame arc lamps; and the Council, in agreeing to this work being done, had in view the relief of the traffic in this electrically lit street. As yet the high pressure system which will be adopted has not been settled, and it may be possible to allot portions of the district to lamps of different make, and thus make the test more comprehensive and valuable. The reason why the question of high-pressure lighting is only now being taken up in Glasgow is that the reproach of having any jet or flat-flame lighting had first to be wiped out. Now that the work of substituting low-pressure incandescents for the old style of lighting is going steadily and quietly on, the main streets and tramway routes are to be brought right up to date and lit according to requirements.

It is hoped to obtain convincing proof as to the economy of high-pressure lighting, although, on the author's own part, a partiality for well-maintained low-pressure lamps at close spacing still remains. The spacing of the low-pressure lamps in Glasgow runs from 40 to 50 yards on each side of the street, and the lamps are all staggered, so that on a diagonal line taken between two lamps seldom more than 30 yards separates them. The 50 yards spacing prevails only on the outskirts of the city.

The burners at present in use in Glasgow, adopted in 1904, are mostly Nos. 3 and 4 Kern, with volumetric governors set at 2·8 cubic feet for the No. 3 Kern, and 3·75 cubic feet for the No. 4. The Kern upright burners are, generally speaking, very serviceable; and although their efficiency may not be so high per cubic foot as that obtainable from inverted burners, the advantages in light distribution they possess are such that, before substituting inverted burners for them, the question would be very fully and carefully gone into. Certainly the upright Kern require thorough and regular cleaning and attention. The method of obtaining this at Glasgow is to give each lamplighter 120 lamps to light, extinguish, clean, remantle, and generally maintain, and be entirely responsible for. Great care has been taken to arrive at the proper length of pin or rod and mantle; and each lamplighter is given a gauge fixing the length of the pin he must use.

All the mantles given out from the store are tested for fit and size. As a check on the use of mantles, each lamplighter must bring back the ash and loop of the old mantle, and the box of the new mantle supplied to him. All mantles are stamped G.C.L.D. Surveyors, who patrol the beats at night, report each morning on the number of broken mantles, the cleanliness of the burners, protector glasses, reflectors, and lanterns. If the lamps on a beat are found in a dirty and unkept condition, the district foreman (there are eight districts) is expected to persistently keep at the man concerned until the beat is put to rights; and the surveyor keeps it under observation until it is right. The policy during the last few years has not been to save mantles but to light the city. It is not asserted that only three or four mantles per lamp are used per annum. As a matter of fact, last year 9·16 mantles per burner were used, and was not thought excessive, as the men are instructed to take down a mantle immediately it shows signs of breakage.

At the present time, inverted burners are being tested on the streets with fairly satisfactory results. An adaptation of the standard square lantern has been made, the features of which are the lighting of the burner by a special bunsen flash light, the cock of which is opened by the insertion of the lamplighter's torch and closed by its withdrawal—a weighted lever arm resting on the trap-door of the lantern. This does away with constantly burning bye-passes, which are always a source of much annoyance in public lighting. Further, the inverted burner, mantle, and protector glass can be raised by means of simple gearing into the roof of the lantern to allow the reflector and lantern to be cleaned without danger of mantle breakage.

Square lanterns are preferable to the ordinary type of incandescent out-door inverted gas-lamp with glass bowl. The breaking of one pane of the lantern may not put the lamp out of action, whereas the breaking of a bowl would. Again, on windy days the direction of the wind may be noted, and the door on the lee side used when cleaning or remantling is being done. Further, a square lantern is more easily repaired, as its parts are entirely get-at-able, especially if the lantern has a hinged top.

As already stated, volumetric governors are used with the Kern upright burners; the result being that there is seldom an incompletely filled mantle. In towns where district governors are used, or where the pressure is fully under control, governors might with advantage be dispensed with. If any kind of governor is used, the velocity of the gas is stifled at the very point where it is most needed—namely, at the air in-take. All burners should be tested at a constant pressure of (say) 3-10ths above the known normal pressure, and the full value of the pressure in the burner secured, though actually paying for slightly more gas than is used. One quite appreciates that it is difficult in a big city to maintain at all times a regular and constant pressure; and for this reason a number of pressure governors are being tested for use with inverted incandescent lamps. Volumetric governors are impracticable with inverted burners. Until these tests of pressure governors are completed, the writer prefers to withhold his judgment. If any members have experience of pressure governors with inverted gas-lamps, he would be glad if, in the discussion, they would bring it forward.

About two years ago, 240 controllers of a clockwork type were fitted in the lamps of some of the main streets of Glasgow. Any delay in further extending the system is not because they have proved to be unsatisfactory; but only for the reason that new types are being daily put on the market. Every type of clockwork controller has been, the author believes, tested in Glasgow. If more were fitted, he would advocate their simplification. For instance, the insertion of the key into the key-hole to change the setting of the clock weekly; the clock being left merely to do its night and morning work of turning on and off. By these means, simpler mechanism could be used. The Glasgow preference for clockwork controllers is due to the fact that with them it is impossible for a complete failure to light up a whole section of the city to occur. The author fears this is still possible with any system of pressure control. Clockwork failures are unit failures. Lately, one or two pressure control appliances were tested in Glasgow, and the author is anxious to go further with this type and test it on a district where the pressures are variable in a constant way, if the expression may be excused. Again, the claims of an electrically-actuated controller have been under test with marvellously accurate results—in fact, one might almost say some system of electrical and clockwork control will be one of the controllers of the future.

Having now referred to controllers, it will appear natural to turn at this point to the question of the change in the class of men required for the work of a public lighting department. Not so very long ago, any old man was thought suitable for lamp lighting. Now-a-days only active, young men should be employed at the work. In Glasgow when an applicant presents himself, he must fill up a schedule as to his past employment, &c. He is then sent to the doctor, the permanent Physician to the Police Department, for examination as to his physical fitness; and

this examination is only the beginning of the doctor's care of him. A medical history sheet is kept of each man, and the state of his health is recorded while he remains in the Corporation service. Each man begins as a substitute stair lamp-lighter, keeping in touch with the division each night until a vacancy occurs. He then gets started as a stair lighter, working 32 hours per week, for which he is paid 15s., rising annually 1s. per week until he has 20s. per week. Promotion to street-lighting follows; and for about 50 hours per week he is paid 25s. per week for his first year and 26s. per week afterwards, with full uniform once a year. The controller beat is the next step; then a patrolling surveyorship may come his way, for which he receives 27s. per week, rising to 29s. per week. He may next get an assistant district foremanship and finally a foremanship. There are between 800 and 900 employees in the Department.

A great deal of work is occasioned by the damage to the plant in the streets by vehicles; and with the increase of motor traffic this damage is extending. The obtaining of evidence is extremely difficult, as is also the collection of the accounts for damage done, and often leads to Court cases. A system of awards to constables is very helpful; and about 90 per cent. of this class of account is recovered. Where the person who did the damage is known, instant intimation is sent to him or to his employer, the account following as soon as possible.

The glazing of the lamps is the subject of an annual contract, which now amounts to between £200 and £300 per annum.

Each of the district foremen makes a monthly return of the mantles and funnels renewed by each lamplighter on each lamp on his beat. From this an abstract is made up showing the total number of mantles and funnels used, as against those used in the same month of the previous year; the increase or decrease is noted; and the average per lamp is ascertained. The weight of the mantle ash and of the loops received into the store from the district offices is also noted. A letter is then sent to each foreman giving the average number of mantles used per lamp in his division for the month, and also the general average over the whole city. Another letter is sent pointing out any abnormal use of mantles on any beat.

To satisfy the department as to the quality of the mantles received, the foreman has to fill up a return stating where a certain make of mantle has been fitted, when it was fitted, and the life of each mantle in days, with any remarks he may have to make as to the nature of the breakage, shrinking of the mantle, &c.

To check the sending out of the men to their lighting as against the scheduled time, the foremen make a weekly return on a form specially provided for this purpose.

To show that watchfulness is not confined to gas lighting, the author would explain that the surveyors (inspectors) see every electric lamp in the city nightly, reporting on the efficiency of the light and the number of lamps found dark. The attention of the Electricity Department is drawn to these on the following morning.

It has been asserted that the aims of the Illuminating Engineering Society are sometimes impracticable, more especially when it attempts to break down the competition between electricity and gas, or when it essays the preparation of a standard street lighting specification. Though agreeing largely with these particular criticisms, one must admit that there is room, ample room, for such a Society; and it should be hailed by all gas engineers as a possible source of great help. In no other service perhaps more than in public lighting of towns of any considerable size is there the need for a specially trained official being in charge; and the work should not be, as it too often is, an extra duty performed perfunctorily by an otherwise busily employed chief official of a municipality. Town planning is being discussed and advocated, garden cities are being laid out every day, and one wonders if the public lighting of these is receiving its due meed of attention. Most gas engineers know how very difficult it is to remedy the faulty spacing of lamps erected many years ago, how difficult to do away with old privileges or to convince the man with a lamp at his gate that it is in the wrong position. A standard specification might have real value for such new work, and one could even go the length of saying that lamps can be made things of beauty and of decorative value, as some of the architects in the old days proved.

Do all gas engineers fully recognize the value of street lighting from an advertising point of view? The means are always at hand in the public lamps of showing what the possibilities of gas as an illuminant are, and when conversation turns on the question of the fragility of gas-mantles, as it so often does, an effective reply is surely to hand when it can be stated that less than a mantle per month, on an average, is sufficient for the public street lamps of a busy city where the mantles are exposed to vibration from traffic and to all the winds that blow.

In conclusion, the author would remark that big cities and towns have a duty to perform in the way of testing new ideas and inventions; and as Lighting Inspector at Glasgow, he hopes to gradually equip so complete a testing station that all figures given and statements made relative to gas, electric lighting, and to kindred appliances may be put to the test. Figures of candle powers are often given which are manifestly exaggerated; and the keener the rivalry between illuminants, the further removed from the truth these figures will probably be. Testing on the street cannot be accurate, although it may have some comparative value. On a wet night all things are glistening, on a snowy night all things are white; a black building, a grey one, or one finished in white tile would alter the readings taken; and what corrections can be made to meet these conditions?

A line of research on a subject on which very much is not known is that in connection with reflectors, and there are many other subjects needing full investigation. If the desire of the author to establish a testing station is realized—and it may be added that Glasgow has not shirked its responsibilities in the past—and if other cities extend their testing, then he would say that the fullest publicity of the results obtained should at all times be given without fear or favour. Members can never hope that all their problems will be solved in a University Research Laboratory; a great deal must be done under their own supervision and control, so that the development of ideas may be continuously worked out.

Discussion.

Mr. Bernard F. Browne (London) said he should not like the opportunity to pass without expressing his appreciation of the splendid state of the upkeep and efficiency of the low-pressure lighting in Glasgow, and also his admiration of Mr. Langlands' lighting staff. It had never been his lot to see a tidier and better set-up staff of lamplighters, who were more after the standard of a big railway company's guards. There was one little point of which he should like to have an explanation. He saw in the beginning of the paper that the author wished to direct attention to the particularly cheap rate at which electric lighting was supplied in Glasgow, so that the members might understand how acute the competition between gas and electricity was. But he should like to mention that in the South of England they did not all have the opportunity of retiring to rest in daylight, and did not quite appreciate the number of lighting hours they had in Scotland; and therefore they were unable to calculate the rate at which electricity was being supplied by night. This would be an interesting point, because they would like to see how gas in Glasgow was placed, from a financial point of view, in its utility as a public illuminant.

Mr. A. Yuill (Dundee) thanked Mr. Langlands for his paper. Coming before them as the Lighting Engineer of Glasgow, that gentleman was, he said, in a position to speak with some authority, and to give some useful "wrinkles," more especially to those who had charge of the lighting. There was near the end of the paper one point he failed to grasp, where the author said: "In no other service perhaps more than in public lighting of towns of any considerable size is there the need for a specially trained official being in charge; and the work should not be, as it too often is, an extra duty performed perfunctorily by an otherwise busily employed chief official of a municipality." As he (Mr. Yuill) had the privilege of occupying the post of Lighting Inspector along with his other duties, possibly this statement might refer to him. But having regard to the friendship that existed between Mr. Langlands and himself, he hoped and trusted that he did not. In some cases, he admitted that where the lighting was in the hands of the gas engineer he was better able to utilize the public lighting of the town or city, and to some extent make an advertisement of it, to show what could be done by the use of gas. It had its usefulness in other ways, because, if the public lighting was kept in good order, an occasion might arise when a consumer came and complained very bitterly about

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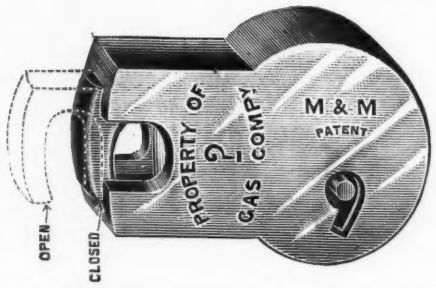

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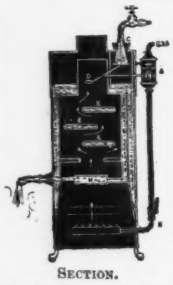

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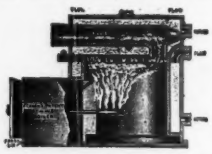

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the want of light. They were not able to discriminate as to whether or not it was bad gas; and if they were able to point out to him that outside his door the gas was burning properly, he might then be brought to see that it was due to something else. In one respect, Mr. Langlands had the advantage of him as Lighting Inspector, because he held the balance equally between the Gas and the Electrical Department. In his own town, the Electrical Engineer took charge of the electrical plant; and he (Mr. Yuill) took charge of the gas plant. With regard to the price for public lighting, he had maintained for some time that the rate ought to have a little consideration on the part of the gas consumers, more especially in those corporations who gave them facilities in the form of free gas-fires and free cookers, which naturally affected the price of gas. When they came to the question of public lighting, they did not require a meter for every lamp. In his own case, they had no meters at all. For this reason he thought they ought to get a cheaper rate; and they now had a rate for public lighting of 1s. 8d. per 1000 cubic feet. In considering the question of public lighting, one was sometimes led to wish there were statistics to prove how they stood in Scotland for public lighting compared with their friends in England; but when they bore in mind the difference in the hours of lighting, it would be readily seen that no comparison could be made. In Scotland they lit up at half-past three and extinguished at eight in the morning; whereas in England they lit up at five o'clock. Therefore there could be no comparison with Scotland. The example which had been set them in London, more especially with high-pressure gas, had shown the great possibilities there were with regard to public lighting. In his own case, they charged so much per 1000 cubic feet. Each burner was noted as to the quantity of gas it consumed, and this was made up each day; and the aggregate for the month ran from 2½ to 3 cubic feet per burner per hour. Mr. Langlands mentioned that in his district they required 1·96 mantles per annum. He (Mr. Yuill) was pleased to say they had done a little better than this. Mr. Langlands also referred to the question of the automatic control of public lighting. This was a matter they ought to consider. He had been doing so for some months. His town was so situated that it was impossible to use the pressure wave, and they found that the clockwork arrangement suited them much better; and he was pleased to say that there had been no difficulty with those which they had had in use for some time. It was all very well, when they were speaking about the automatic control of gas, where the price was high—say, 3s. or upwards; but when they came down to 1s. 8d., they found that there was not much economy in the adoption of controllers, because all the saving was on the men's labour, and the difference in the price of gas did not amount to very much.

Mr. W. J. Liberty (London) remarked that Mr. Langlands had tabulated his figures well; but, at the same time, in his (the speaker's) opinion, it did not carry them far with regard to the improved methods of high units of lighting, as applied to great cities, like the one which he represented. There were little details of figures in the paper with regard to spacings, which he would not then go into; but he was surprised to see that Mr. Langlands had still 10,000 more rat-tail and flat-flame burners than incandescent. He was, however, glad to see that they were principally in closes, and not in the public thoroughfares. The reason why some of the paper did not appeal to those in the South was that, in the first place, they knew nothing of rat-tail burners, and they knew nothing of closes. The flat-flame burner had long since been forgotten; and they were trying to forget anything about the upright burner. Therefore he was pleased to see that Mr. Langlands was on the right track, when he was systematically taking away his flat-flame burners and substituting for them incandescent burners. There was one thing which was analogous in the City of London, perhaps—namely, stair lighting. It was four years since they had altered all the stair lighting in the Temple, Gray's Inn, and the other Inns of Court. There they had been told that, unless they could show an improvement over the flat-flame burners, they were not to meddle with them. They showed that they could save 4s. 6d. per annum—not providing a square lantern, but a swan-neck adapter. So satisfied were the Temple authorities with them, that they put them over the whole of their buildings, where they were otherwise going to have electric light. The high-pressure portion of the paper had interested him most, because he had had experience of it when it was first introduced on the bridges of the Metropolis by the late Mr. William Sugg, followed by the Gaslight and Coke Company with the Keith system of water-driven plant at about the same pressure. It had not been in operation more than two or three years before it was called on to be scrapped; and they were tapping the high-pressure Beckton mains to get the same result—namely, that much-talked of lighting in Queen Victoria Street, which, in its turn, quickly became obsolete, and was now about to be scrapped also. Then, in 1908, they had a startling advance made by the Keith high-pressure system, as great as that from the flat-flame to incandescent upright burners, or the low pressure when they went up from 2 inches to 10 inches. This was the inverted burner that was installed in Fleet Street on long brackets, projecting 7 ft. 6 in. over the footway from the house-fronts—a 1500-candle power lamp at 54 inches pressure, consuming (say) 25 cubic feet of gas. An installation of this type of lamp, with the inverted burner, was put into operation; and, strange as it might seem, though it was not two years since they were fast getting away from that, and were now working at a pressure between 80 and 90 inches, or (say) 3 lbs. water pressure. It was at this pressure that the new lamps in Westminster were working, as also the new installation in the City of London, in New Bridge Street, and the centrally-hung lamps in Cannon Street. He did not say that they had yet reached finality in 3 lbs. pressure. Experience and experiment must decide this. He believed the City of Birmingham were considerably above this pressure in their new mains—namely, 10 lbs. He was a great believer in centrally-hung high-power lamps for street lighting, suspended over the centre of the roadway (especially in cities of the size of Glasgow); and in this he was speaking from experience. He had advised their adoption on account of the great efficiency which was obtained from them, owing to the height at which they could be placed; their spacing ensuring perfect uniformity in illumination. The saving of expensive columns close together in a long run of streets, was of great importance. Some examples of this method of centrally-hung lighting would be found in the four installations recently put up in Cheapside, the eastern and western portions of Cannon Street, and in Watling Street, in the City of London. There the lamps were not only centrally-hung, but were on a lowering gear with automatic connections and winches on the side walls to disconnect the lamp, draw it from the centre to the side, and lower it down to the footpath for attention—thus obviating the necessity of having ladder-towers down the centre of the busy roadways. With regard to the height of these lamps, he did not agree with Mr. Frank Hawkins, of Rugby, who gave, in his paper recently at the Junior Institution of Engineers, 30 feet as the correct height. Experience had shown him (the speaker) that 2 feet or 3 feet lower was much better. Those in Cheapside had been fixed at a height of 27 ft. 6 in. above the roadway. In Watling Street, it was the same height; while the high-power Keith lamps at the eastern end of Cannon Street, put up by the Gaslight and Coke Company, were only 26 ft. 6 in. above the centre of the roadway, and those of the Charing Cross Electricity Supply Company at the western end of Cannon Street, put up in 1907, were but 28 feet in height. At the average height at which the lamps were placed the best results were obtained, as was borne out by experience. In Cheapside, the Oliver "Oriflamme" arc lamps, fitted with Peard prismatic reflectors, largely increased the horizontal rays, and allowed the lamps to be used with clear outer globes, and reduced glare at an angle of 30°, taking the reflected light from the facias and plinths of the whole of the thoroughfare, so that they were able to read the signs of the shops along the footpath. It showed the value of reflected light in street lighting, and likewise made it possible to extinguish the side street lighting for a considerable distance. The same remark applied to the high-power centrally-hung gas-lamps in Cannon Street, where the lamps, though without reflectors, had clear globes; the effect produced being both pleasing and practical. There was an entire absence of glare; while, as an evidence of the economy of this form of lighting, he would mention that at the western end of Cannon Street (the experiment of the Charing Cross Company) the extinguishing of the small lamps in the side streets had, it was stated, contributed 45 per cent. of the cost of the main road lighting, though to get this result some little sacrifice had to be made in the matter of uniformity of spacing. It was the practical efficiency of the centrally-hung lamps that he referred to; for, by suspending them in the centre of four cross-roads

or open spaces where sometimes more than four roads met (and this without adopting the American's calculation, who, when he was exhibiting a 1000-candle power lamp, claimed 4000 candles, because it gave 1000-candle power in four directions), the centrally-hung lamp, having the same illuminating power in each direction, enabled the lamps in each street to be extinguished for (say) 160 feet, according to the power of the central lamp. To show the usefulness of these lamps, by next Friday the whole of the rests and the lamps on them would have been swept away, so that the Royal Procession might take the centre of the roadway; and, for the benefit of the millions of people who would be parading those thoroughfares at night, centrally-hung lamps had been adopted from Whitehall to the City—being suspended from the chimney-stacks or the parapets of the houses. The expense of taking away the rests and lamps, upsetting the pavement of the roadway, and then bringing them back again, would be enormous. He would conclude by saying that, with gas at 1s. 8d. per 1000 cubic feet in Glasgow, and with the serious opposition they were having from their Electricity Department, where they were offering a 1500-candle power lamp, it was time that they went into the question of high-pressure lighting more seriously than they had done hitherto; and he hoped that Mr. Langlands would not sit on the fence for two years, looking at his high-pressure lamps when he got them, because he thought the experience he had in large cities would warrant him in coming to a conclusion much earlier. If they would adopt some of these high-pressure lamps in parallel roads where the cross roads met, they would find that, up to about 300 or 400 feet of the cross roads, they would be able to turn out all their lamps, with perhaps one in the centre—the main road lighting it right through. At least, this was his experience; for he was doing the same thing himself. While they had been discussing this question of high-pressure lighting, and the rivalry existing between the high-pressure lamps and the flame-arcs, the now notorious Holborn contract was being considered by the Holborn Borough Council. There the question had become so acute that they were discussing a joint tender, written on one Company's notepaper; and they had come to the conclusion to have the lamps just half-and-half.

Mr. George Helps (Nuneaton) said this was a truly practical paper by a practical man. It had taken him three hours to go through the paper with Mr. Langlands. His point was that they had been expending hours in unnecessarily discussing papers with regard to manufacture; and they were now driven to discussing in minutes the important matters of distribution. Whatever the cause of it was, he hoped some remedy would be found for it. Mr. Langlands called attention to the electricity people catering for lighting, and said it was very interesting that they should supply the light while the gas people were supplying the gas. This was a concise way of putting it. Mr. Langlands referred to his partiality for low-power lighting; and he quite agreed with him in this. When they wanted 500-candle power, let them have high-pressure; but when they wanted up to 500-candle power, let them have low pressure. Mr. Langlands had also given them particulars of the square lantern which he was apparently in favour of. He had raised a question on this point with Mr. Langlands, and had discovered that he was not really in favour of the square lantern, because he was only in favour of a lantern which could be maintained economically. Mr. Langlands had designed a very interesting lamp indeed. In fact, it was one of the most interesting lamps he had seen. He removed, by simple gearing, the burner into the roof of the lamp, so that it could be cleaned; and, in addition to this, he lit it with a torch instead of with a bye-pass. He thought the members ought not to leave Glasgow without seeing this lamp. Up went the torch, and the thing was lighted. Mr. Langlands had not been able to show any high-pressure lighting; but let them just consider what opportunity there was in Glasgow for high-pressure distribution. The whole of the street lighting there now was not of the best, because of the difficulties in dealing with the varying pressures throughout. When Glasgow got down to the distribution of gas at about 100 lbs. to the square inch, and used it at 3 inches, they would see an illuminating effect in the streets that had never yet been seen in this country or in Europe. He wished to thank Mr. Langlands for having brought so excellent and useful a paper before them.

Mr. Walter Grafton (Glasgow) said there were in the paper three points he wished to touch upon. The author showed a preference for upright burners as compared with the inverted. In Glasgow they had a gas which was different from that in the South of England, or in those works where they supplied a mixture of coal gas and carburetted water gas. Glasgow gas was wholly coal gas, and gave a flame which was larger in area. Consequently, he found, from experimental evidence, that it was impossible to introduce, by means of the nipple, more than 7 volumes of air; hence they could not get out of the Glasgow gas its maximum illuminating effect. Taking a fixed nipple with a fixed pressure, and passing through it (say) 4 cubic feet of gas in an upright burner, the mixture of air going through would be 22 cubic feet. Taking the same conditions, but ejecting air through it, it would be found that they passed only 3½ cubic feet; but the actual quantity going through the mantle fabric was 38½ cubic feet, or an increase of 75 per cent. This explained away the fact that carburetted water gas took in more air than coal gas. It was entirely due, it seemed to him, to the viscosity of the gas. It had nothing to do with the molecular attraction; the greater the gravity, the greater the quantity of air injected into an upright burner. Mr. Langlands distinctly stated in his paper that the use of a governor or a regulator would interfere with the proper efficiency of the burner. This was quite true. Mr. Langlands asked the members to give him some experience of what would be found with regard to these regulators. He (Mr. Grafton) would suggest that the best way to get out of it was to sell gas by what he would call a "pressure sliding-scale." In Glasgow there were something like eight or nine districts. They might subdivide them into sixteen or more, and put into each district a recording pressure-gauge—one to show the maximum and the other the minimum; and upon the quantity of gas sent out during lighting hours the charge would be made. This would meet Mr. Langlands' difficulty about not getting sufficient air into his burner, because, after all, there was something in the wealth of pressure. He found that this would work out disadvantageously to his department—that if the pressure was not up to the mark the percentage would come off his account. If, however, the pressure happened to be greater in the district, they would have to pay more for the volume of gas that went through. This would do away with much of the trouble experienced in Glasgow.

Mr. E. A. Harman (Huddersfield) said that he had been amazed at the splendid staff of the men engaged in the public lighting in Glasgow. One thing that had struck him was how one man could maintain at least 120 lamps in the excellent condition in which they found them. But, on looking again at the paper, he saw it stated that the duty of the inspector was to keep at the men. This explained it a little. Farther on in the paper, however, he saw a reference to the medical aspect of the question; and this was to him a very important point. Not long ago, any old man was considered useful for the work; but in Glasgow a man was first sent—he was going to say to the University, but at any rate to the doctor who was the permanent physician of the Police Department. This was only the beginning of the doctor's care of him. He did not know what his chest measurement had to be, nor his height; but presumably he had to be vaccinated. Perhaps Mr. Langlands would give them some further information on this very interesting point. It was not surprising that they had such excellent men, when they were all of them subject to high-pressure examination.

Mr. Edward Allen (Liverpool) said Mr. Langlands had stated that figures of candle powers were often given which were manifestly exaggerated; and the keener the rivalry between illuminants, the farther removed from the truth these figures would probably be. When he (Mr. Allen) read this before the author read the paper, he, of course, assumed that it referred to electric lighting. In reading his paper, however, Mr. Langlands had interpolated a reference to high-pressure gas lighting, and had said that such figures as 70-candle power were impossible. He (Mr. Allen) would not like it to go from this meeting that such statements with regard to high-pressure gas lighting were to be received with caution. He himself had obtained more than 60 candles; and he would not be surprised if in some cases even 70 candles could be maintained. He hoped Mr. Langlands would make the *amende honorable* in this respect.

The President said, being in such close touch with Mr. Langlands in business matters, he did not propose to criticize the paper. He would only say that those who knew

the author's work best knew how much he had done to improve the street lighting of Glasgow. He was glad to say that not only had the lighting of the city been much improved, but the working of the department was put on a proper basis, so that they were now able to do the work on the most economical lines. He was glad to say that his work was properly recognized by the whole of the Corporation, and that he had justified his selection for the post he now filled.

Mr. LANGLANDS, in reply, said that he thought the *amende honorable* should come first. He appreciated what Mr. Allen had said; but he was not going to concede everything to him. They should stick to the truth; and the truth would carry them through. He wanted to get the best for Glasgow. He had said what he had done, because he had been suffering from 30-candle power efficiency from low-power gas; and he objected to such vague statements as 70 and 80 candle power with nothing to back them up. He wanted to have the details. Mr. Browne had asked for his lighting hours. They were 3780 per annum. He thought this worked out at ¾d. per unit for electricity, which was very low. He was pleased to have Mr. Yuill's criticism. He had had many talks with that gentleman over public lighting; and any question of a personal attack upon him as Lighting Inspector was far from his mind. What was really in his mind was that it was left to their Borough Surveyor, who had nothing akin to gas lighting or electricity. Public lighting was too important a subject to be left to anybody to handle. In Glasgow, they had a practice of making a saving by turning one burner out at midnight. Mr. Liberty had given him a "good doing" for his want of action in Glasgow as far as high pressure was concerned. He would accept the chastisement; but he wanted to give his reason for what he had done. He found that the administration was a little bit antiquated; and he was determined, before he did anything, that he would have the administration right. Now he hoped they would go further, and get some good illumination. In fact, he would not be satisfied until he had Glasgow standing well in the front with regard to public lighting. He was pleased to have Mr. George Helps on his feet. That gentleman had come North, and he had shown him Glasgow—that was all. He had shown him what they were doing; and he was glad to have Mr. Helps' friendship, because he was a fighting man, and he admired fighting men. With regard to Mr. Grafton's criticisms, he did not want to bring in anything about his own case. In his actual testing of efficiency with a No. 3 burner he could get an efficiency of 18-candle power per cubic foot; and with the inverted he obtained 21-candle power, worked with many nipples. The variation was so slight that he was going to get more than this before he would make a radical change. He was pleased to have Mr. Harman's criticism; and he really wondered whether that gentleman knew he was on the lines of the Labour Party in Glasgow. He was determined that only the best men could do public lighting; and he was going to try to get them. Mr. Wilson had refrained from criticizing the paper; but he and that gentleman could always discuss public lighting, and he was glad there was such a friendly feeling existing between them.

MODERNIZING A MEDIUM-SIZED GAS UNDERTAKING.

By C. F. BROADHEAD, of Middleton.

On looking through the Institution "Transactions" and Technical Press records, one cannot help being struck by the wealth of detail given with regard to separate and distinct items of practice in modern gas-works; but there are few instances which can be said to comprehensively cover an entire gas undertaking. The present paper is a modest attempt to sum up in a lucid manner the advantages gained by the application of modern methods, wherever possible, to a medium-sized undertaking at Middleton during the past five years; and, in addition, it deals with plans for further improvement in the future.

Apart from the question of whether such a communication may be of a useful nature, it can be said that medium-sized works do not appear to have been too lavishly represented in respect of papers in the past. Although the ground may have been traversed before, it may not be an unfruitful exercise to see what can be achieved in a short time, starting from a bed-rock of debt—heavy capital expenditure and scrap plant in a circumscribed area. What by contrast the possibilities of progress are for substantial concerns in a strong financial position may be well imagined.

As to what is a medium-sized works, the average make of British works last year was approximately 120 million cubic feet; and the average capital outlay, £80,000. The total capital outlay of British gas-works was £135,000,000. The make of gas at Middleton is 135 million cubic feet; and the capital outlay, £135,000. The position of the undertaking (which is owned by the Corporation) at its worst was summed up in the local Press as follows: "There has been enough tinkering at the gas-works to end or mend any concern; and the suggestion has been made to us that Middleton would be better off if the gas-works were closed-down altogether, the whole of the town supplied with electricity, and the obligation to people interested in the gas-works paid off out of profits. The suggestion is at first startling, but it appears to be eminently practical. We are heartily sick of the gas question."

The following figures will show there was some cause for complaint: In 1902, the net loss was £3725; in 1903, it was £962; and in 1904, £570—a total of £5257. As the reserve fund amounted to practically nothing, the balance owing to the Bank at the end of this period was over £5000. In 1905, the price of gas was advanced 3d. all round. In spite of this, however, the net profit for the year ending 1906 was but £184; while the gas sold per ton had fallen to the low figure of 8943 cubic feet.

It is from this point the author proposes to commence, giving an outline of what has been done with regard to the plant, the distribution, and the financial departments respectively, with the consequent results.

Before proceeding to erect urgently needed new plant all through the works, application was made to the Local Government Board for powers to borrow £16,600; and after a prolonged controversy, almost the whole of the amount was sanctioned. Before describing the alterations to plant, it may be remarked that the figures given in this connection, both previous and subsequent, are taken from the yearly statements, so are strictly comparable.

As Middleton has been supplied by gas produced solely by inclined retorts for ten years, the experience gained may be of some interest. In his address to the Midland Association of Gas Managers this year, the President remarked upon his particular inclined retorts as a considerable source of trouble and a constant anxiety; and though he now regarded them as reformed characters, like all such they needed special thought and attention. The Middleton experience is almost an exact replica of the above; but it is not too much to say that the final result has been complete success.

To go back to the first stage in 1906, the make per ton was but 9988 cubic feet. There were two reasons for this small make—viz., irregular charging, on account of unsuitable coal employed, and uneven heating, caused by faulty construction of the settings. Upon the judicious buying and mixing of coals depends to a large extent the success of inclines; otherwise a properly-charged retort becomes more a matter of chance than anything else. The only possible remedy for the constructional defects was the entire demolition of the existing settings and the substitution of new ones. The old ones were chiefly remarkable for their complicated construction which surely must have reached the limit of intricacy in brickwork. In the new beds, simplicity is the keynote; the combustion chambers being large, and the travel of the heating gases slow. The need to alter a damper is extremely rare; and even then ⅛-inch makes all the difference in twenty-four hours between a moderate and a good heat.

By the employment of a Féry pyrometer, it has been possible to obtain valuable information with regard to variations in temperature due to different sized charges and other reasons. It is impossible to enumerate these here; but, in passing, it may be said that the average retort temperature (taken between the draw and charge) is 990° C.—the lowest reading being 940° C. and the highest 1040° C. The combustion chamber temperature is kept steadily at 1400° C. without much difficulty. Even with considerably increased temperatures, no trouble has been experienced with regard to the stability of fire-clay material, which, in spite of exhaustive experiments and reports, seems to be mainly a question of £ *s. d.*

One thing is certain—extreme heats are by no means

favourable with moderate coal charges; the resultants being pitched-up mains, stopped pipes, deposition of naphthalene, and decreased candle and calorific power, no doubt owing to the splitting-up of the light-giving hydrocarbons and consequent formation of scurf on the retorts. The installation of a tar-tower, by which the hydraulic mains are run completely dry every eight hours, has reduced pitching-up troubles to a minimum. As at the majority of works, the tendency at Middleton is towards heavier charges and a longer period of carbonization. With heavier charges, stopped pipes and hydraulic main troubles diminish, and the make per ton decidedly improves without a corresponding deterioration in the quality of the gas. At the same time, retort temperatures must be raised proportionately to the increase in weight of the charge; otherwise nothing but a decrease in make per ton is to be expected. To obtain the best yield, sufficient heat and duration should be applied to drive off all the volatile gases, and that weight of coal put into the retort which will cause these gases to be subjected to the least amount of decomposing heat. With large charges, the variation in the make-quality figure is considerably reduced; and it is reasonable to suppose this will be reflected in the constancy of the composition of the gas on the district.

Owing to defects in the charging apparatus, it has been impossible in the past to always accurately determine the weight of a charge; but this may be taken at approximately 7 cwt. A new charging machine has been devised with a view to trying the effect of different sized charges and durations, and endeavouring to find that weight and duration which is of greatest benefit in inclines, taking all things into consideration—namely, make per ton, production per mouthpiece, and calorific and candle power. Beyond a certain point it does not pay to go; and so far as can be seen at present, a 10-cwt. charge of eight hours' duration seems of the greatest all-round benefit.

The Board of Trade returns for last year give the average make per ton of all gas undertakings as 11,161 cubic feet. The author makes no claim that anything exceptional is being done at Middleton at present, as the make per ton for last year was only 11,502 cubic feet. But considering that, starting with 9900 cubic feet to the ton, in less than five years the make has been increased by 15 per cent., and at the same time that the cannel has been reduced from 11 per cent. to *nil*, and benzol enrichment abolished, the achievement may be regarded with a certain measure of satisfaction. The aim now in view is 12 tons of coal per bed per day, yielding a make per ton of 12,000 cubic feet, and per mouthpiece of 9000 cubic feet, with a net calorific value of 525 B.Th.U., using good quality coal costing at the moment under 12s. per ton delivered. This has already been attained on the summer make.

The remaining half of the retort-house roof is now being raised, to enable the erection of either a further bench of inclines or an installation of continuous verticals. The difference between intermittent verticals and well-worked inclines does not appear to be sufficiently marked. If the impressions already gained by a close inspection of their working and results are confirmed by further experience of continuous verticals, the question of the retort of the future will be solved, so far as Middleton is concerned.

The works are situate in a cramped position in the very centre of the town, where ground-space and a mitigation of the smoke nuisance are of first importance. In addition to this, the ease of manipulation and the flexibility of continuous verticals are undoubtedly greater than those of the best inclines. But the most important point of all seems to be that verticals are best capable of taking from the coal the largest quantity of gas of the quality suited to present and future requirements; the reason being that carbonization of coal in verticals is simply the carrying of the full retort theory to a logical conclusion.

The question of candle power seems inextricably bound up in the possibility of gradual cooling; and the system in which the best gas comes off at the top of the charge, and has not to pass through a mass of incandescent coke or over heated retort walls, seems the most reasonable. At the other end of the retort, consider the saving in heat-energy by the cooling of the coke in the retort itself, and so heating the secondary air in place of the present loss sustained by quenching. In more than any other system does the success of vertical retorts appear to the author to depend upon the solidarity of the structure and the quality of the fire-clay material.

Until last year, the coke-handling plant consisted of an elevator inside the retort-house delivering on to a conveyor 20 feet above the ground-line, which, in turn, deposited the coke either into hoppers or on to the stack 50 yards away. Since its inception ten years ago, this plant had cost well over £2000 in repairs and renewals. As the author believes in handling coke as far as possible in bulk, this method has now superseded the old in a manner which is simplicity itself, and particularly adapted for medium-sized works. The elevator has been displaced by a 20-feet steam hoist, which raises the coke and waggons bodily on to a gantry, by means of which the coke is delivered directly from the waggons into the hoppers or on to the stack. The plant itself cost £500; the coke waggons, £70; and the necessary alterations, £30. Covering the same period, the breeze available for sale with the new plant was 270 tons, against 750 tons with the old elevator and conveyor. A small coke breaking and screening plant is contemplated to encourage local trade.

Prior to an installation of water-tube condensers, the cooling of the gas depended upon a length of 200 yards of 14-inch cast-iron main, placed along the retort-house wall, which resulted in the temperature of the outlet gas in winter being as often as not above 100° Fahr., and the exhauster stopping several times in consequence. Owing to restricted ground space, it was resolved to erect a vertical condenser to deal with a million cubic feet per day. This has been connected up to the old condensers; and by using one or the other, or both, the temperature of the gas in summer and winter can be regulated with ease. When it is remembered that a water-cooled condenser of this description occupies but 7 square feet of ground, the value of such a piece of apparatus to works such as at Middleton, troubled by ineffective condensing plant, will be recognized. The cost of the condenser itself was £290, and that of the connections including alterations £140.

It is the author's firm belief that slow travel by means of a large area is desirable if possible, or, if not, a long length of foul main, as the formation of naphthalene is materially affected by variable cooling conditions. So many and unstable are the hydrocarbon compounds that it is possible for numerous combinations to form and reform during the early stages of changing temperature. The gradual cooling of the gas tends to the absorption of naphthalene by the more stable hydrocarbon compounds. The possible improvement of the gas at this stage synthetically is a question for reference to scientists; but the next best thing is to take every care to prevent undue analysis, the bulk of which takes place between the retort and the condenser outlet, or when the gas attains its temperature equilibrium. At Middleton, there has been no trace of naphthalene whatever since the introduction of heavier charges, more gradual cooling conditions, and a lower candle power. It seems almost incredible that attempts should have been made to wash naphthalene out of the gas by means of special apparatus and solvents, and that at the same time either cannel, water gas, or benzol enrichment should be resorted to.

Until three years ago, a half-million cubic feet per diem exhauster had frequently to deal with over three-quarters of a million cubic feet per day, with no relief machine in case of emergency and with gas at over 100° Fahr. containing large quantities of tar. There is now installed a million cubic feet per day machine; the old one being left for use during the summer months.

Although two retort-house governors were fixed together with the new settings, they have not been used, as it has been found quite practicable to maintain a level gauge without their aid. This has been done by a combination of the usual exhaust gas-governor, together with a 2-inch bye-pass and cock connected from the inlet to the outlet of the exhauster. The cock on the bye-pass can be adjusted to give any vacuum required. It has been found of great advantage to place a lubricator on the steam-pipe directly above the governor throttle-valve. This simple addition ensures a freedom of working unobtainable in any other way.

The diagrams appended show exhaust sheets before and after the alteration. It will be seen from the third chart that on a windy day it is possible to have less variation on the vacuum side of the exhauster than on the outlet of a district governor. At the same time experience shows that it does not always follow that a straight line denotes the best make per ton obtainable. For some reason or other, there is a difference in the volume of gas made at certain times during

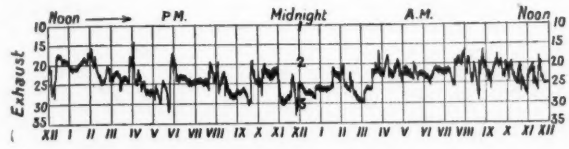


Fig. 1.—Vacuum Register, June 5 and 6, 1910.

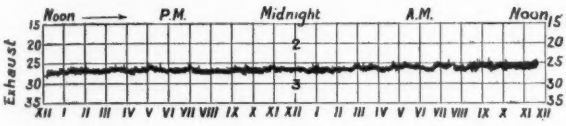
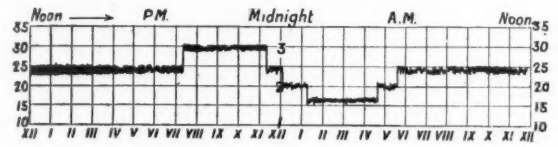


Fig. 2.—Vacuum Register, Dec. 25 and 26, 1910.



Wednesday, April 19. Thursday, April 20.

Fig. 3.—Pressure Register.

the twenty-four hours. Probably one reason may be that, however carefully the overhead hoppers are filled, the most suitable coal for inclined charges comes down first and the smaller after.

Until last year, there was only one boiler of sufficient size for winter work; but a Lancashire boiler, 6 ft. 6 in. diameter and 20 feet long, has since been installed, with forced draught apparatus. The cost of the boiler alone was £235, and the seating £45. At the time of coupling-up the old and new boilers, the steam lines were entirely renewed and rearranged. The old washing and scrubbing plant consisted of a rotary washer of 400,000 cubic feet per day capacity, together with two dilapidated scrubbers, 6 feet in diameter by 15 feet high, the combined efforts of which were totally inadequate to deal with the quantity of gas made during the winter months. The scrubbers were at once consigned to the scrap-heap, and their place taken by a million cubic feet per day Livesey washer, followed by a tower scrubber, consisting of an old boiler, 30 ft. by 7 ft., placed on end and filled with a series of wooden grids.

The rotary washer is at present being overhauled, refitted with bundles, and moved from its old position to that of third in the series. During these alterations, the opportunity has been taken to collect this part of the plant, with its connections, together in a compact group; so that a million cubic feet per day can now be dealt with on less ground-space than was formerly occupied by plant of half the capacity. The sequence of the Livesey washer, tower scrubber, and rotary washer forms an effective method of tar and ammonia extraction, and is of considerable assistance in the purification proper. The total cost of the plant was £565, including alterations and connections.

With regard to purification, the use of lime has been totally abandoned. In fact, the old lime boxes have already been dismantled; and on the site thus made available is being erected a new sulphate of ammonia plant. Oxide of iron in the form of bog ore, is now solely relied upon. There seems to have been a remarkable tendency of late towards accidents in purifiers, due either to carelessness or to too active material. It may be a conservative view; but considering the small cost of purification, it seems preferable to pay a little more as a kind of insurance premium. The purifiers now in use consist of four boxes, 30 ft. by 20 ft. by 5 ft.; three being always at work and one off for changing. These were originally fitted with ordinary grids in two tiers, giving each box a capacity of 40 tons, but now contain hurdle grids, with a single depth of material of 3 ft. 6 in.—making the holding capacity 50 tons.

The cost of these hurdle grids amounted to £180; and the financial advantages reaped by the change are summed up as follows:—

Cost of purification, gas sold, old system, 1909, 0·5d. per 1000 cubic feet
" " " " " new " 1910, 0·3d. " " " "
" " " " " av. 73 corpns., 1910, 0·4d. " " " "

Probably few towns have such a wide limit between the maximum and minimum day's output as Middleton. The record output two years ago reached 856,000 cubic feet, while the least was 154,000 cubic feet. Eight days' fog, during which the gas in stock fell as low as 90,000 cubic feet, seemed sufficiently conclusive proof that the storage capacity was somewhat too small for comfortable working. At that time there were two holders in work—a four-lift of a capacity of 380,000 cubic feet, and a two-lift of 180,000 cubic feet. There was also a tank, 60 feet in diameter by 16 feet deep, containing, below the water line, the wreckage of a disabled holder. This was cleared out, the columns taken down, and a small three-lift spiral holder erected; increasing the storage capacity by 125,000 cubic feet. As there is no space anywhere near the present gas-works, it is proposed to replace the two-lift column-guided holder by a three-lift spiral holder. This will mean an additional 80,000 cubic feet, bringing the total to about three-quarters of a million cubic feet, which is very near the average maximum day's make.

In a fascinating lecture delivered at the beginning of the year at the Manchester University, Mr. F. D. Marshall declared that, instead of the ton or thereabouts of sulphate of ammonia at present got from 100 tons of coal, according to the nitrogen content of the coal, the yield should be nearer 5 or 6 tons. But, unfortunately for medium-sized gas-works, the possibility of adopting plant whereby this could be attempted appears exceedingly remote. As the make of sulphate at Middleton during the past five years has only averaged about 18 cwt. per 100 tons of coal carbonized, the Corporation would appear, according to Mr. Marshall, to have lost a small fortune. Seriously, the losses in an ordinary way have been extensive, owing to the plant, which was over 20 years old, being thoroughly worn out. It has recently been scrapped entirely, and in its place there is in course of construction a plant of the latest design, capable of producing two tons of salt a day, consisting of stills, rectangular in shape, having one side removable from top to bottom, a saturator of the solid lead type, and other up-to-date accessories.

Previous to deciding on a new plant upon the usual lines, investigations were made as to the possibility of a direct manufacture process, but without finding any reasonable prospects of success. Such a scheme may no doubt be worked in conjunction with coke-ovens, where the gas is a bye-product; but the risk appears too great for its adoption where gas is the prime factor. The old sulphate house is being pulled down, and the site, which is adjacent to the coke-hoppers, utilized for the breaking and screening of coke. The cost of the new sulphate plant alone, including erection, will be £620, and alterations of building, foundations, &c., account for a further £80.

The Corporation having last year an Omnibus Bill before Parliament, advantage was taken of it to insert some of the most recent clauses relating to the supply of gas; the most important being a reduction of candle power, together with the substitution of the No. 2 "Metropolitan" burner for the "London" argand. The author had the unusual experience of witnessing in one Committee room a protracted fight between gas companies and corporations concerning merely the substitution of one burner for another, and then, on behalf of a corporation, assisting to get through in record time, not only the same alteration, but a reduction in the prescribed number of candles from 18 to 14.

It is not the intention of the Corporation to reduce the illuminating power to 14 candles with a No. 2 burner all at once, but instead of forcing, with consequent trouble, the flat-flame users to adopt the incandescent system, to educate the consumers in this respect by means of burner maintenance, and then follow up with the reduction. A premature reduction in illuminating power is the least likely method of obtaining the desired result in the quickest way. As on a carefully compiled estimate, however, only 15 per cent. of the gas consumed in Middleton is burned through flat-flames, little difficulty should be experienced in this direction. The average illuminating power supplied each year during the last three years has been 18¼ candles (No. 1 burner), 17¼ (No. 2), and 16¾ (No. 2); and during this time not one complaint, either written or verbal, with regard to the quality of the gas has been received.

In addition to the foregoing, powers have been obtained to inspect, supervise, supply, and maintain consumers' fittings and appliances, the first portion of which has been rigidly put into force. The power to compel the use of anti-fluctuators has been found of value in at least one instance, where a large gas-engine, being at the end of a district, and

only using gas as a stand-by when the suction plant went wrong, was in the habit of aggravating its already great enough offence by upsetting all the non-offensive consumers in the neighbourhood.

In a brief space of time, distribution methods have undergone a change which can only be described as revolutionary. Even within the short memory of the author, a prospective consumer would most likely be informed that the gas department might be good enough to fix him a service provided he produced a guarantee as to his respectability and paid a proportion of the cost, to say nothing of a good, stiff deposit. If he demurred, the attitude generally adopted was that of "take it or leave it." There seemed a rooted disinclination on the part of gas authorities to give the consumer any assistance or information whatever. This is in striking contrast to the present publicity efforts.

The author would here remark that he considers the scheme recently brought forward by the Publicity and Special Purposes Committee of the Institution is a sound business proposition, and ought to be supported by every gas undertaking to the fullest possible extent. What seems to be most required, apart from general advertising, is expert advice as to advertising methods best suited to divergent districts. What is there to prevent gas undertakings spending much more money themselves than will be granted to any Central Committee, providing the advice given proves to be on the right lines? It is not too much to say that electrical competition has provided such a stimulus to the gas industry that the revenue lost by electrical replacements has been more than balanced by gains due to increased energy in the gas sales departments. In fact, so important has the distribution of gas become that it is increasingly evident that it is desirable, even in the case of moderate-sized undertakings, to detach its management from the general commercial department, and place it under the separate control of a head with a special aptitude for such work, the very nature of which makes the results achieved almost in direct ratio to the thoroughness of the efforts put forward.

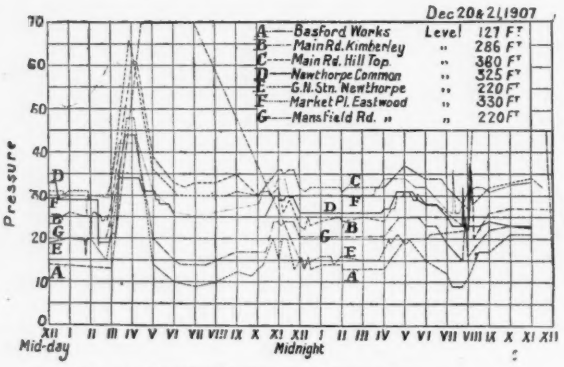

Dec 20 & 21 1907
A—Basford Works Level 127 Ft
B—Main Rd. Kimberley " 286 Ft
C—Main Rd. Hill Top " 380 Ft
D—Nawthorpe Common " 325 Ft
E—G.N. Stn. Nawthorpe " 220 Ft
F—Market Pl. Eastwood " 330 Ft
G—Mansfield Rd. " " 220 Ft
Pressure
Mid-day
Midnight

Fig. 4.—Showing Variations of District Pressures.

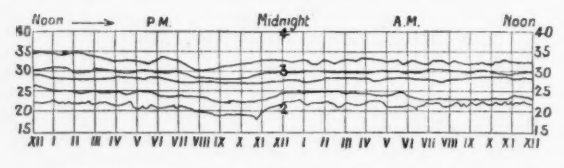


Fig. 5.—Pressure Register.

Fig. 6.—Recording Calorimeter.

At the same time, no amount of energy or improved gas-consuming apparatus can compensate for lack of efficiency at the point of supply; such efficiency depending on pressure and calorific value. And yet, what little attention, comparatively, seems to be given to these important factors. Referring to the charts figs. 4, 5, 6, in the first it will be seen that the pressure in twenty-four hours varied from 70-10ths at the gasholder outlet to 8-10ths (taken directly off the main) at the worst point in the district. An attempt was made at Middleton to obtain the nearest approach to the ideal of a constantly unchanging pressure at the point of consumption, by previously ascertaining district pressures and varying the initial pressure accordingly. This, with pressures up to 25-10ths, resulted in total failure; the nearest approach to anything like perfection being that indicated by fig. 5, obtained with a constant governor pressure of 3 inches all through the twenty-four hours. Fig. 6 gives a typical day's calorific variation as registered by Beasley's recording calorimeter—a valuable piece of apparatus which the author considers no fair-sized gas-works should be without.

The increased pressures required nowadays can scarcely mean anything but increased leakage; but when the lower grade gas which is now (or ought to be) sent out and the increased efficiency are taken into consideration, the advantages easily outweigh the loss. In beginning to supply gas to an entirely new district, nothing seems more reasonable than to use small high-pressure steel mains with a governor on each service. Indeed, it becomes more and more apparent that, even under existing conditions, the addition sooner or later of such governors will become a necessity.

All gas-fitters and plumbers at Middleton have now to be registered. They must conform to the standard sizes and rules supplied to them, and notify new work for inspection and testing before the fixing of a supply. A suitable place for the meter is also insisted upon; the loss to the Corporation through fixing meters in damp or dirty places, such as underneath sinks, &c., having been very great. A commencement is being made to take off, test, and repair a certain number of meters each summer. Their condition and lack of accuracy have fully justified such a course.

Since cooker rents were abolished two years ago, 500 cookers have been fixed, in addition to a like number of grillers. The stove invariably supplied is a second-grade packed and enamelled slot cooker, which is admirably suited to the requirements of a working-class town. The question of gas-fires presents a more complex problem, and no decision as to policy in this direction has yet been arrived at. In the past, no less than 500 fires of the old type had been purchased; and such was the author's opinion of these, that half of them have been scrapped and written-off the books. The remainder will follow as quickly as it is convenient to bring them in. A scheme for the exploitation of the new type will then be taken into consideration.

The maintenance of consumers' burners has at last become an accomplished fact. Much time and thought were expended upon the consideration of the best method of putting the idea into practice; and it was ultimately decided that the work should be done free, and the retail price charged for materials. This avoids an irritating small charge for labour, and at the same time provides an answer to any question likely to be raised by the local plumbing fraternity. As the latter do not care to undertake maintenance on account of the small profits on this class of work, little objection can be taken to gas undertakings doing it free if the trade prices for materials are charged. It is doubtful whether maintenance undertaken in this manner pays its way. But it is certainly equivalent to an appreciable reduction in the price of gas to those consumers who take advantage of it; and its educational value is probably greater than is generally supposed.

Cards attached to ordinary meters, giving readings, consumption, and information regarding cooking and maintenance, &c., are distinctly useful. In furtherance of educational aims, it is intended to open a district show-room, not merely for the purpose of selling apparatus, but mainly as a centre where the best in connection with the use of gas for all purposes can be seen and expert advice in every direction readily obtained.

Two years ago, the author's opinion was sought with regard to the lighting of a large new cotton mill. Permission was given to make experiments, and four separate systems were installed in the same room over different machines—two being high pressures, with upright and inverted burners, and two low pressures, with Kern burners in one case and inverted in the other. The operatives themselves chose the upright Kern burners with ordinary pressure—a view that was endorsed by the directors, in spite of the fact that they were informed that the high pressure, light for light, would cost only half as much. Five floors, containing 100 burners each, were fitted up on this system, which is giving entire satisfaction; but had the same work to be carried out to-day,

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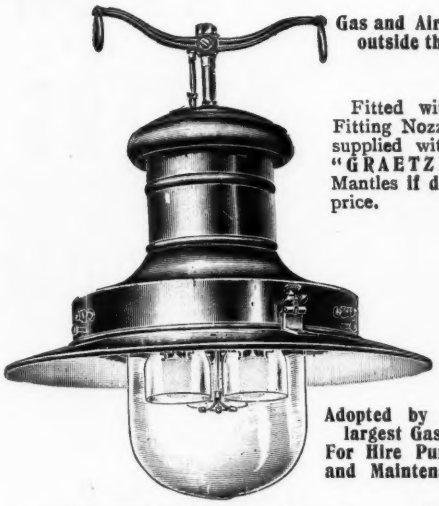

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125-Candle Power per Burner.
Gas Consumption about 4 c.ft. per Burner per hour.

Adopted by many of the largest Gas Companies For Hire Purchase, Rental and Maintenance Systems.

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SPECIAL PRICES QUOTED upon application stating probable quantity required.

IMMEDIATE DELIVERY FROM STOCK.

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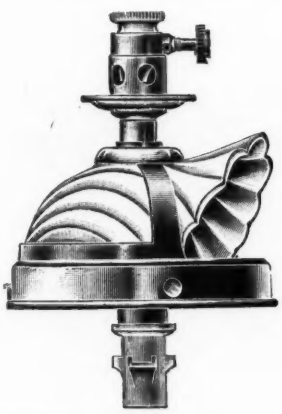

12,956. Standard Size, **32s.** doz.
13,580. New **Medium** Size, **28s.** dozen.

THE "ORIN."

13,588. Burner only. Carries Standard Size Mantles and Globes, **33s.** dozen.

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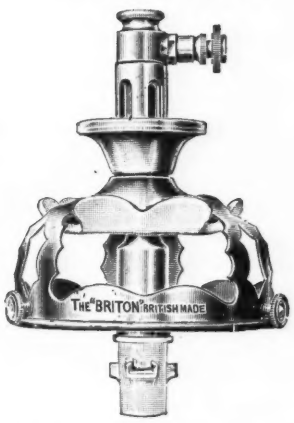

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13,415. New **Medium** Size, **28s.** dozen.

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the probability is that inverted burners would be substituted for the upright ones.

In mills and factories, there seems to be general neglect in giving sufficient attention to the lighting; and high-pressure systems naturally suffer more than low on this account. In many cases it would pay to have an experienced man to look after the lighting alone during lighting hours, for so much depends upon the lamps being in good working order. High-pressure street lighting, which has achieved such a distinct and instantaneous success in larger towns, has at present not been taken up to any extent by medium-sized undertakings. But in any case, public lighting ought to be under the direct supervision of the maintenance department, as each gas-lamp is a silent, but telling, witness to the efficacy or otherwise of the incandescent system.

Having wandered from the retort to the maintenance of burners in a disconnected attempt to describe the efforts made to bring a crippled undertaking into line with progressive concerns, the question arises as to the financial result; for, after all, the success of gas undertakings is to be measured in terms of pounds, shillings, and pence.

To consider, now, financial results at Middleton, the past ten years may be divided into two clearly defined periods, the first half of which showed a total net loss of £4400, while the second has resulted in a net surplus of £11,000. The reserve fund stands at 3 per cent. on the capital, which looks little enough against the average of 16 per cent. of other corporations; but as half the net profit must now be placed to sinking fund and half to reserve fund, this should right itself in a short time.

The author has always favoured the idea of an inclusive price for gas, and has been fortunate enough to persuade his Committee that this was the right thing. Two years ago, cooker-rents were discontinued, last year meter-rents followed, and this year the price of gas is to be reduced by 3d. per 1000 to ordinary, and 3½d. to prepayment consumers. These concessions mean £2500 per annum to the consumers, to say nothing of the saving in income tax. The difference in price of ordinary and prepayment gas is now only 4d., including discount; and had it not been possible to afford a substantial reduction all round, it would have been still less. With an inclusive price per 1000 cubic feet, and considering the fact that the undertaking does not supply any fittings, there is no reason for a greater margin; and one cannot help feeling there is some little justification for the recent agitation for more favourable terms to slot meter consumers, for whom the difference in price in some cases approaches 1s. per 1000 cubic feet.

This leads indirectly to a consideration of what is likely to become in the near future a question of importance—namely, differential prices. In Middleton, at one time a separate service and meter were supplied for cooking purposes, and gas was charged at a reduction of 4d. per 1000 cubic feet. But this system proved of so little advantage that the practice was abandoned, 600 duplicate meters brought in, and the lighting rate charged. This should not be taken to indicate a condemnation of differential prices, but only of this particular system.

Gas companies will no doubt take their line of action mainly from a profits point of view. But they should beware of creating a false position by too great a difference in price between gas for lighting and that for heating. If consumers are enabled to obtain gas for heating purposes at a low rate, the danger is that they may be induced on this account to pay the extra cost of lighting by electricity. When all has been said, both an incandescent burner and a gas-fire require gas for its heat units. Cooking by gas is more advantageous than by coal; and it is not too much to hope that, considering the splendid advances made by the makers, they may shortly put on the market a gas-fire able to compete with raw fuel without the aid of an excessive differential price.

Corporations stand on a somewhat different footing to companies, yet it is just as unfair to charge one consumer 1s. 6d. per 1000 cubic feet for heating gas and another 2s. 6d. for lighting gas as it is to make one ratepayer pay a portion of another's rates through the medium of his gas bill. But, it will be urged, is all the prospective business foreshadowed by the coming great change in the methods of hygienic heating to be let slip because of a system of differential prices wrong in principle? Certainly not. Instead of having a separate scale of charges for lighting and heating purposes, why not base the price entirely on the quantity consumed, irrespective of the manner, with a widely extended scale? Now is the golden opportunity for gas undertakings to be first in the field with a suitable gaseous fuel at a price that will ensure its use for all purposes.

So long ago as 1881, Sir William Siemens said: "I am bold enough to go so far as to say that raw coal should not be used as a fuel for any purpose whatever, and that the first step towards judicious and economic production of heat is the gas-retort, in which coal is entirely converted into gas and coke as in ordinary gas-works." This thirty years ago; and the price of gas in most towns still prohibits its use in domestic fires and for many industrial purposes! Especially is this the case in towns where the corporation own the undertaking, and, by their shortsighted policy and lack of pluck to face any increase in the rates, persist in keeping them down by means of so-called gas profits. If this super-tax on gas consumers were done away with, in a comparatively short time the annual loss in rate aid might very well be recovered by increased sales, to say nothing of the advantages reaped by the gas consumer and in atmospheric cleanliness.

In conclusion, some apology is perhaps due for certain digressions from the legitimate ground that it may be held is covered by the title of this paper. The paramount impression left by three years' strenuous reorganization and reconstruction is that of the clumsiness of the whole process of gas manufacture and distribution; and the imagination depicts a gas-works of the future where continuous retorts are coupled to outside producers, the washing and purifying plant turned into a process of direct sulphate of ammonia manufacture, making 100 lbs. to the ton, and gasholders converted into high-pressure storage tanks supplying gas of a standard calorific value at a standard pressure through small steel mains to consumers who have never heard of the term flat-flame burner.

Until such time arrives, however, it will be the aim of the Middleton gas undertaking to avoid paying anything towards the relief of the rates, and to give the consumer the best attention possible to the point of consumption for an inclusive charge per 1000 cubic feet, with a probable differential rate according to the amount consumed, irrespective of the purpose for which it is used. That we are going in the right direction is admitted, even by our old and severe critic the "Middleton Guardian," which stated, in a recent issue, that "Confidence in the undertaking has been restored in the public mind, and, considering handicaps, the department is to be congratulated on the state of efficiency found there to-day."

The author regrets not having yet been able to introduce a profit-sharing scheme; being convinced that co-partnership is the one solution so far propounded at all capable of meeting a great social problem. In determining upon engineering alterations and financial adjustments no haphazard scheme has been followed; but each has been founded upon the essential principle that the total ultimate success of an undertaking originates from that of interdependent details, also that "If 'twere done when 'tis done, then 'twere well it were done quickly."

Discussion.

Mr. C. F. Botley (Hastings) said, as far as his experience went, the paper seemed to be on very safe lines. There was only one thing he would like to point out to Mr. Broadhead, and it was that there was a great deal in having a price for gas to include the meter-rent. He wished to congratulate Mr. Broadhead heartily on his paper.

Mr. G. M. Gill (London) said Mr. Broadhead had stated that extreme heats were by no means favourable with modern charges; the resultants being pitched-up mains, stopped pipes, depositions of naphthalene, and decreased candle and calorific power. He thought the advocates of heavy charges would agree with this. Then Mr. Broadhead went on to say that at the same time retort temperatures must be raised proportionately to the increase in weight of the charge; otherwise nothing but a decrease in make per ton was to be expected. In his case, they found that when they increased their charge from eight to twelve hours, they reduced their dampers. They could work with their dampers as much as two-thirds open with an eight-hour charge; and they reduced the dampers when they increased the weight of the charge.

Mr. H. E. Bloor (Carlisle) wished to join with the previous speakers in their commendation of Mr. Broadhead for the excellent manner in which he had brought his undertaking from being a bankrupt concern into a prosperous

one—at the same time being able to give a substantial reduction in price to the consumers. There were several points in the paper upon which he would like to ask for information, more particularly with regard to the working of the old inclined retorts and the improved design and working of the new retorts. As one having no practical experience whatever of working inclined retorts, it would have been valuable to him if Mr. Broadhead had informed the meeting as to what constituted judicious buying of coals for inclined retorts. Mr. Broadhead stated that upon the judicious buying and mixing of coals depended to a large extent the success of inclines; and information on this head would be valuable. If Mr. Broadhead could give it to him, he should be personally grateful. It appeared that the old settings were chiefly remarkable for their complicated construction, which must have reached the limit of intricacy in brickwork. He presumed if they were complicated, it was ingeniously thought-out by somebody, with a view to obtaining increased efficiency. Mr. Broadhead found that from a cheaper form of construction better results were obtainable; and it would be interesting to him if the author would give some of the points in the old setting that proved to be unfavourable. He did not follow Mr. Broadhead when he said that, even with increased temperature, no trouble had been experienced with regard to the stability of fire-brick material, which, in spite of exhaustive experiments and reports, seemed to be mainly a question of £ *s. d.* He took it Mr. Broadhead did not mean in any way to suggest that the carrying out of experiments on the manufacture and testing of refractory materials was useless or mistaken. He presumed that, if it was only a question of £ *s. d.*, to get a high-class material they must know first of all in what direction to spend the money. He rather thought the author spoke of taking all things into consideration; and he referred to the production per mouthpiece, calorific power, and candle power. It occurred to him (Mr. Bloor) that the highly important question of residuals must come into account. He dissented from Mr. Broadhead, who, at the previous meeting, rather seemed to imply that considering the coke returns was a mistake. It seemed to him that this was distinctly a question of £ *s. d.*; and the yield of coke and residuals was a highly important matter, which ought not to be lost sight of. He rather thought some of the members would not agree with Mr. Broadhead when he said that the most important point of all seemed to be that verticals were best capable of taking from the coal the largest quantity of gas of the quality suited to present and future requirements—the reason being that carbonization of coal in verticals was simply the carrying of the full-retort theory to a logical conclusion. The coke plant that Mr. Broadhead had designed appeared to be very suitable for small gas-works; and he must thank him for the suggestion, as Carlisle was in want of it at the present time. With regard to naphthalene, Mr. Broadhead suggested that washing plant was rather a mistaken and an unnecessary expenditure. He would point out that the methods of dealing with naphthalene varied so much that they could not deduce from the circumstances of one works what would suit another. On taking up his appointment at Carlisle, he asked the foreman fitter what was their experience with naphthalene. The man looked blank at the question; whereupon he (Mr. Bloor) explained that it was something that stopped-up the pipes. The man said he was sorry; but he did not know anything about it. He must confess that since he had reached Glasgow he had received some complaints from home; and he should have to consult Mr. Broadhead as to how to deal with them. He should further like to ask Mr. Broadhead if he were quite sure of his ground when he said that one reason for there being a difference in the volume of gas made at certain times during the 24 hours might be that, however carefully the overhead hoppers were filled, the most suitable coal for inclined charges came down first, and the smaller after. His experience was that the contrary would have been the case, and that the small would come down first. Possibly something in the construction of Mr. Broadhead's hoppers might explain this. Then further on Mr. Broadhead described his storage capacity; and it seemed to him that it might possibly be worth reconsideration, because if he proposed to spend money on one holder with the object of getting an extended storage accommodation of 80,000 cubic feet, it did not seem to carry the matter much farther.

Mr. George Helps (Nuneaton) was very interested to note that the author of the paper considered the scheme recently brought before the Publicity Committee was a sound and businesslike proposition. He wondered if Mr. Broadhead was in the same position as he (Mr. Helps) was. He should like to ask if he had sent his cheque along. He (Mr. Helps) had not; but he hoped it would not be many days before it was sent, and he trusted everybody else would follow his example. Mr. Broadhead had said that the increased pressure required nowadays could scarcely mean anything but increased leakage. He (Mr. Helps) did not agree with this statement in any shape or form. They might have as much pressure as they liked, and no leakage at all. If they wanted to reduce their leakage, they should increase their pressure.

Mr. T. Canning (Newport) said he had been surprised that Mr. Broadhead had not gone in for telpherage straight off (there was the possibility that it was cheaper in its first cost than the system at command) and so to speak avoid the expenditure that might be necessary to provide motive power. He (Mr. Canning) considered that it would be more economical in the long run, because Mr. Broadhead would find it much cheaper than the working of the coke-handling plant he had erected. In addition, he thought it might be possible to reduce his breeze still further; and he had no doubt the system at Tonbridge would, on the whole, have served better than the one he had produced.

Mr. H. Kendrick (Stretford) said there were one or two points which were connected with the distribution rather than the manufacturing side of the works which had been dealt with by the previous speakers. In his paper, Mr. Broadhead had stated that all the gas-fitters and plumbers at Middleton had now to be registered. He (Mr. Kendrick) ventured to suggest that the mere registration of gas-fitters and plumbers was not enough. It was of no use to register the gas-fitter and plumber in these days, unless one was absolutely certain that he possessed the requisite knowledge for the work. Several companies in the southern part of Manchester had adopted the plan of putting their men through an examination in the board-room as to their capabilities, before they would grant a certificate of registration. This had already had an effect on some of them; and they found that there was a decided improvement in the class of men coming forward for registration, even in the course of twelve months. It was hoped that in the near future even a better class of men would be coming forward to take up this most important branch of their work. Dealing with some of the other points in the paper, there was a great controversy as to the wisdom, or otherwise, of charging cooker-rents. In Manchester, they had strenuous supporters on both sides. The opinion generally expressed in favour of rents was that a great many cookers were sent out, no rents being charged, simply because they happened to be a convenience for occasional use. People who required a cooker for general use were always prepared to pay a small rent for it. In contradistinction to this, it was found in some districts that the portion of the cooker that was used most frequently was the hot-plate. A great many of the gas undertakings in the Manchester district were now sending out a griller which could be used instead of the whole cooker; and the increased consumption showed that the average quantity used through these grillers approached nearly to the average consumption through the whole of the cooker. Whereas the cost was considerably less, the return was very much greater. With regard to the maintenance of consumers' burners, the same thing would apply. Supplying materials at nearly cost price, and making only a small charge for the work, had answered very well in many districts. The irritation at the small charges to which Mr. Broadhead had referred he did not think was felt in very many cases. If every undertaking went into this question as closely as many of them had done, they would find a great improvement in the lighting effect obtained by the consumers, and a considerable check to the operators of the electric light undertakings, especially in the private houses. There was just one other point, with regard to differential prices. He was one of those who believed in differential prices, especially for daylight gas, and more particularly for cases where gas was consumed practically every day in the week all the year round. In such cases, the standing charges must be considerably less for the gas so supplied than they were for the ordinary lighting gas, where they had two hours in the summer against eight or nine in the winter. The amount of plant which had to be provided for the winter consumption was only partially used during the summer time; whereas with the every-day load they had a much smaller proportion of plant for the same quantity of gas, and consequently they

could charge a much lower price. He congratulated Mr. Broadhead on his admirable paper, and on the work he had done.

The PRESIDENT said they had had a short and pithy discussion. Mr. Broadhead asked if he might write his reply; and as this would save time, they would agree to it, and also tender him their thanks for his very able paper.

NOTES ON THE CORROSION OF SERVICE-PIPES.

By JAMES M'LEOD, of Greenock.

At the various meetings of the Western District Commercial Section of the North British Association of Gas Managers the question of the serious corrosion taking place in the service pipes has been discussed; and it was this circumstance which, when asked by my former Chief—Mr. Alexander Wilson, the President—to submit a paper to the Institution caused me to fix upon it as one which might be both to my advantage and that of the members to investigate to some extent.

The corrosion of iron itself is a matter of much complexity, even when the iron is merely exposed to ordinary atmospheric conditions. How much more so must it be when exposed to a nominally non-oxidizing atmosphere such as coal gas? It has been shown experimentally that bright iron can be exposed to air and moisture in the pure state for a period of several months without rusting taking place; and accurate and painstaking experimental work in proving this might lead to the inference that on the traces of carbonic acid in the atmosphere lies the onus of this troublesome rust. Other careful experimental work has, however, shown that rusting can take place even when carbonic acid is rigorously excluded from contact with the iron. Moody proved that when pure air, iron, and moisture were in contact without corrosion taking place, the introduction of a trace of carbonic acid at once set up the oxidation of the iron.

Lambert and Thomson, in an elaborate research confirmed Moody's work, but incidentally showed that corrosion would occur even when carbonic acid was absent, as mentioned above. Baker suggests the oxidation as being perhaps due to the occasional dissociation of the oxygen in solution in water, and that in the non-dissociated state only was it capable of attacking iron, and when dissociated it was inert as regards iron. The author mentions this experimental work to indicate generally the difficulty of the problem; but it may be generally asserted that there must be a substance or substances present in the moisture necessary to all rusting to render the moisture a better electrolyte. In the case of gas-pipe corrosion, a suitable electrolyte is never wanting, as carbonic acid, cyanogen, and ammonia are never entirely absent from the gas, and consequently from the moisture deposited from the gas. But it is only a phase of corrosion which concerns gas engineers, and concerns them deeply in many places.

These are days when the cost of distribution is an ever-increasing burden on most gas departments, but possibly a not absolutely unwelcome one, because wisely increased expenditure on this aspect of gas politics is a clear sign that gas departments have now grasped the modern trend of gas policy and are firmly determined to hold what has been won, and to press forward to further achievements for an industry to which civilization owes so much. Attention to services, and thereby to the comfort and convenience of consumers, is a bounden necessity for all gas departments.

What is there in modern gas practice which leads to more rapid corrosion of the service-pipes laid—granting that more rapid corrosion is taking place, which appears to be the general opinion in the western district of Scotland? The most radical changes which have taken place in practice are the employment of higher heats in carbonization, and the sole use of oxide of iron for purification, with revivification *in situ*; and also, but not possibly least of all, in its bearing on the question is the abandonment to a large extent of cannel coals of all qualities in the desire to produce a really good coke. If these three or four causes be examined in detail, some explanation of the corrosion of service-pipes will probably be found. The increased temperature of carbonization means, according to investigations on the subject, increased carbonic acid, sulphuretted hydrogen, carbon disulphide, and cyanogen; and all of these bodies, with the possible exception of carbon disulphide, might be regarded as aids to corrosion. It also means a decreased amount of oily matter for deposition as a protective coating on the inner surfaces of service-pipes.

The abandonment of lime purification meant that, instead of a trace of, and often no, carbonic acid, from 2 to 4 per cent. would be present in the purified gas. Sulphuretted hydrogen should not be present in the gas with either lime or oxide purification, and the author believes rarely is. What, then, produces the free sulphur found in the samples of corroded material taken from the service-pipes, and analyses of which are embodied in these notes? Is it the carbon disulphide? Surely not, as it is not generally admitted that oxide of iron interacts with this body. The presence of the free sulphur must be attributed to the action of minute traces of sulphuretted hydrogen (which escape absorption in the purifiers) on the oxide of iron, with formation of sulphide, and subsequent oxidation to oxide, with separation of free sulphur by the action of the trace of oxygen in the gas; this trace of oxygen being due in some cases to excess of air being used for revivification, and in others, where air is not added intentionally, simply to the trace of oxygen generally present in purified gas.

Samples of corroded material taken from various service-pipes in different parts of Greenock showed the following results so far as tested.

The presence of the oxide of iron itself might now be touched upon, as to its origin. What took place in the service-pipe to produce it? If we take it that the service-pipes are of red steam quality, not coated in the inside—and good heavy service-pipes are an economy in the long run—the inner surface of the metal is subjected to direct contact with moisture from the gas in the presence of carbonic acid, ammonia, and cyanogen—all being aids to rapid corrosion, as already mentioned. Little voltaic cells are set up, and corrosion consequently goes on and oxide of iron is produced. This oxide of iron interacts with sulphuretted hydrogen, producing sulphide; the trace of oxygen before mentioned then acts on the sulphide, with liberation of the free sulphur. Cyanogen further combines with the oxide of iron, to produce a ferrocyanide. The action is a continuous one; more and more oxide of iron being produced as time goes on, and ultimately the pipe is choked—naphthalene helping in the filling up, and the deposit of oxide acting as a nucleus for it to settle out upon. It may be stated here that all the samples contained naphthalene except Nos. 9 and 11.

No. of Sample.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Free sulphur and oils	5·69	9·80	1·09	2·88	4·70	0·71	2·77	5·47	*Nil*	0·51	0·06	0·56
Cyanogen	2·5	4·50	1·56	6·55	3·12	3·13	1·63	1·95	*Nil*	5·49	*Nil*	6·90
Ammonia	0·95	0·53	0·50	1·15	0·85	0·58	0·44	1·02	0·10	0·54	0·10	0·68
Peroxide of iron	..	51·84	..	..	..	..	..	..	..	..	0·02	..
Protoxide of iron	..	7·24	..	..	..	..	..	..	..	..	..	..
Sulphuric acid (combined)	..	1·32	..	..	..	..	..	..	..	..	..	..
Lime	..	0·93	..	..	..	..	..	..	..	..	..	..
Siliceous matter	..	6·15	..	..	..	..	..	..	..	..	0·05	..
Organic matter, Naphthalene, &c.	..	11·77	..	..	..	..	..	..	..	..	..	..
Moisture	..	5·92	..	..	..	Carbonic acid					6·52	..
						Oxide of lead					0·20	
											83·30	
		100·00									100·04	

The question naturally arises, Why should the inner surface of the plates of a gasholder not corrode rapidly when they are so exposed to the action of the cyanogen, ammonia, and carbonic acid, which are always present in the gas? Is there, it might be asked, a definite reason why this corrosion should not proceed with much greater rapidity than in the service-pipes, getting first contact, as the holder plates do, with these helpers of corrosion? The only feasible explanation is that there is left in the gas when it reaches the holder some oily and tarry matter, which, depositing on the metal, forms a thin skin, which proves impervious to the action of ammonia, carbonic acid, and cyanogen.

In demolishing the old sulphate plant at Greenock, the author was somewhat surprised to find that a wrought-iron main which carried the waste gases to the purifiers was not eaten through, as he confidently expected it to be. It had stood for many years the action of gases heavily charged

with sulphuretted hydrogen, carbonic acid, and cyanogen; and the action of these gases had been inhibited in some way. Possibly the action ceased when the skin of the metal had been attacked, and the product of this action had resisted further action and protected the metal from deeper attack.

In taking down some 38-year-old annular condensers, the author found again that the faulty state these were in was due more to want of regular painting of the outer surface of the inner tubes than to chemical action from the gas. The condensers were so erected that painting of the inner tube was a matter of the greatest difficulty. But this question of corrosion bristles with difficult problems; and one can only search for the probable cause and avoid it if possible. In one case of boiler-tube corrosion which occurred when the author was at the Provan Gas-Works, Glasgow, of two new boilers side by side, and fed by the same water, one was comparatively unattacked; in the other, magnetic oxide of iron was literally shovelled out—the ends of the tubes being completely eaten away. The boilers were made by the same firm at the same time. The water used was very pure; the only exceptional point being that it contained more than an average amount of ammonia. But that this was the cause is somewhat discounted by the fact that only one of the boilers was attacked. One could simply say that this water, slightly contaminated with ammonia, should not be used, as it served to produce a good electrolyte for the passage of currents from physically differing, or perhaps chemically differing, points in the metal of the tubes, and so promoted corrosion.

Having briefly touched on the influence of higher heats on the corrosion of the service-pipes by the greater amount of gaseous impurities produced, and on oxide purification, with its leaving of all the carbonic acid in the gas, and on revivification *in situ*, with its possible slightly greater percentage of oxygen in the gas available for the formation of oxide of iron or rust, the only remaining possible cause of corrosion is the abandonment of cannel coals to a large extent. This means that there is now a distinctly lower amount of oily matter available for deposition as a protective covering in the pipes, as the percentage of illuminating hydrocarbons in the gas is now appreciably less, and there is consequently less chance of the formation of a thin protective covering of oily deposit. These then are the causes of corrosion, so far as the author can see. But there can be no prevention; and he is afraid it is one of the penalties to be paid for the improved methods of working. The gas engineers of Scotland who know now what the naphthalene problem is, would never think of returning to cannel coals for the sake of getting rid of naphthalene; they therefore simply benefit by the painfully bought experience of their English *confrères*, and adopt one or other of the cures found satisfactory by them. There can, however, as already stated, be no cure for the corrosion of service-pipes; it must be accepted and borne with. But service-pipes of the best steam quality can at least be used, and the life of services thereby lengthened and troubles lessened.

From the analyses of the samples from the pipes given above, it will be seen that the free sulphur varies from 0·51 to 9·8—the latter, however, not being a Greenock sample; the highest Greenock sample being 5·69 per cent. The amount depends probably on the age of the deposit; and on this the author has no data. The cyanogen also varies between wide limits from 1·56 to 6·90 per cent.; but the ammonia does not show such wide variations, running as it does from 0·44 to 1·15 per cent. This might be expected; there being an easily reached limit to the amount of ammonia the only slightly moist oxide could take up. There are two special samples, however, to which attention should be specially directed. These are Nos. 9 and 11, taken from two houses in Greenock from the compo. pipes between the meter and cooker. They were, when first examined, somewhat puzzling. The author first thought that oxide of zinc from the galvanized services had been blown forward, though it seemed extraordinary how it could pass the meter; but the analyses, as will be seen, show it to be a carbonate of lead.

The question then naturally arose as to whether it was a product of corrosion by the action of the carbonic acid on the lead of the pipes, or whether it arrived with the consignment of compo. pipe. Only two cases have come to notice of this deposit in compo. pipe. The makers of the compo. pipe say they are not aware of anything in the process of manufacture which would leave a deposit of carbonate of lead in the pipe, and yet it seems not readily credible that action on the compo. pipe by the carbonic acid of the gas should produce such an amount of carbonate of lead. The very large number of lengths of compo. pipe fixed between the meter and the cooker or fire in Greenock, and the fact that only two of these stoppages have been reported to the author, causes him to think that some other cause than the action of the gas has led to the presence of the deposit of carbonate of lead. In Greenock, the question is now before him as to whether the galvanized service-pipes which he found being used when he became manager, and which had been used for eight to ten years previously, are justified or not. If not, then a considerable saving would be effected by their abandonment, as will be seen from the following prices which are current:

Price of Tubing per Foot.

¼ in.	⅜ in.	½ in.	⅝ in.	¾ in.	1 in.	1¼ in.	1½ in.	2 in.	2½ in.	3 in.	4 in.
Galvanized.											
1¼d.	1½d.	1¾d.	2¼d.	2¼d.	3½d.	4½d.	5⅜d.	7⅜d.	10½d.	11½d.	1/1⅝	1/8
Red Steam.											
1d.	1⅛d.	1⅜d.	1⅜d.	1⅜d.	2½d.	3⅜d.	4½d.	6d.	8¼d.	9d.	10⅜d.	1/3¾

Average difference in cost . . . . . 20·4 per cent.

The average percentage then in favour of the red steam tubing is about 20 per cent., which, on the requirements of galvanized goods for the present year, would mean a saving of £115—quite an acceptable economy. The author, of course, is aware that very few gas departments use galvanized tubing for their services; but without some investigation, he was not prepared to abandon the dearer article, having had some experience of so-called cheap steam-valves and cheap paint.

Objections to galvanized steam quality service-pipes may be summarized as follows:—

1.—The galvanizing is attacked by the ammonia; and once the skin of zinc gets broken, exposing the iron below, a small cell is set up, with zinc and iron as the anode and cathode, and moisture from the gas containing ammonia, cyanogen, and carbonic acid as the electrolyte. Corrosion proceeds rapidly and oxide of iron is produced.

2.—The galvanizing is therefore no protection for the interior of gas-tubing, but rather an aid to corrosion.

3.—The difference of 20 per cent. in the price is not justified by results, but quite the reverse.

In order to see the effect on galvanizing of ammonia vapour, the author put in hand some weeks ago certain simple experiments, the results of which are now exhibited. Some 4-inch pieces of galvanized steam-tubing were cut and placed in bottles with a small capsule containing carbonate of ammonia and also water in the bottom of the bottles; equal weights of carbonate of ammonia and of water being used in each case. Three of the bottles contained air; and in the other three the air was displaced by coal gas. The action has been extremely marked, even in the comparatively short time of the experiments; the pieces of zinc in the first three bottles showing a heavy incrustation. The fine, bright surface of the zinc is completely gone; and it is evident that it is well advancing towards disintegration. In the three bottles in which coal gas has taken the place of air, the action is very noticeably less pronounced than in those with air present. It would seem, then, that air or oxygen materially helps this action of ammonia on zinc. Even, however, in the bottles with coal gas, the bright surface of the zinc is gone and attack on the zinc has begun. The bottles with the gas in them were so treated that air could not have access. Of course, in practice the trace of oxygen and trace of ammonia are generally present together in coal gas, and so attack on the zinc would go on. It might be said, however, that, granting the truth of all this, it only deals with the inside of the galvanized tube, and that the galvanized tube would stand better in contact with the soil. This is not so; for, as will be seen on examining the contents of the bottle in which has been placed a piece of galvanized tube together with ashes and water from one of the producer pits, the zinc has been rapidly and somewhat curiously attacked.

In Hole's monumental work on gas distribution, it is stated that the "acidiferous nature" of the soil surrounding services (more especially where that soil contains ashes and refuse) has a strongly corrosive action on the pipes. The author's experience is that he has never met with a sample

of ashes or ashpit liquor that was not strongly alkaline. His attention was first of all drawn to this some years ago at the Provan Gas-Works. There being at Provan a very complete and well-equipped set of baths and lavatories, the men naturally choose to wash themselves in the warm water of the external producer ash-pits; these producers being, of course, sealed in water. The skin of their hands chipped and cracked; and on this being mentioned to the author, he found, on analysis, that the water contained a considerable amount of free alkali.

Now alkalies generally prevent corrosion of iron, possibly by taking up any carbonic acid present. In his opinion, then, it is not the "acidiferous nature" of the ashes that causes corrosion, but the greater porosity of the soil when ashes are present. This greater porosity permits access of air and moisture containing carbonic acid, which latter will, of course, not always be absorbed by the alkali of the ashes. Corrosion, therefore, starts readily, and goes on continuously, in such a porous soil. This explanation does not, however, cover every case. In spite of the alkalinity of the producer ash water, a polished piece of tubing, immersed in water with some ashes also present, shows the somewhat curious effect that the underside of the tube where not covered by the fine dust from the ashes settling out from the water and lying on the metal, is perfectly fresh; but where the ashes have settled down, a blackish stain has been produced, showing that action of some kind has taken place. But the nature of this action is obscure.

Discussion.

The PRESIDENT remarked that they were very much indebted to Mr. M'Leod for his short but interesting paper on the corrosion of service-pipes.

Mr. DAVID VASS (Airdrie) said the conclusion Mr. M'Leod had come to, he thought, was the correct one. That the older service-pipes were preserved in some mysterious way, was evident from the fact that in his town the services that had been put in within the last six years were readily attacked in the method mentioned, whereas those that were older gave no trouble. It was quite possible that this might be due to the inner coating of the higher hydrocarbons when a richer gas was used. He learned from the experience of others that, where purifiers of larger area were used, this trouble was not met with, which pointed to the fact that, where gas could be entirely freed from all possible traces of sulphuretted hydrogen, it might be possible to keep clear of the trouble. Mr. M'Leod came to the conclusion (which was not very satisfactory) that there was no remedy for it; yet he pointed out the remedy himself. He (Mr. Vass) had come to the conclusion that the remedy, where the purifiers were small, was to be found in introducing a small quantity of lime in the purification of gas, and so getting rid of the least trace of moisture, or any great excess of moisture, in the gas before going into the mains. He found that some of the services which had given them the greatest trouble were within 100 yards of their own works, and others as much as 1½ miles away; but in all cases they were services that had been put in within the last six years.

Mr. SAMUEL GLOVER (St. Helens) said, simple as this subject might have seemed to some of them when they first saw the heading of it, he thought the author had proved that after all it was a very important one. Anything that had to do with the distribution of their chief product was deserving of consideration, because every consumer was required to have a service-pipe, which might be affected by this question. He thanked Mr. M'Leod heartily for his analysis of the possible causes, and the changes which had taken place leading to these causes; but he wished to point out to him that he had not arrived at a state of things which was hopeless. He was aware of the experience of the Scottish gas engineers, as compared with those in other parts of Great Britain; for he believed it was well known that his friend the late Mr. William Young and himself had worked at the question of naphthalene prevention very much at the same time as their friends the Botleys, of Hastings, were working at it. When he came to confer with Mr. Young about naphthalene, he was very much in the same position as Mr. Bloor's foreman at Carlisle; he did not know anything about it. Scottish engineers had only recently begun to have any experience of naphthalene; and they would have more of it. As their processes of carbonization approximated more closely to those adopted on the other side of the Tweed, they would get more trouble from naphthalene. Mr. M'Leod seemed to contradict himself when he said that gas engineers in Scotland, who knew now what the problem was, would never think of returning to cannel coal for the sake of getting rid of naphthalene. This seemed to suggest that the cannel coal which used to be carbonized in Scotland was not now very largely employed. He should like to assure the author that what cured the naphthalene trouble would also provide him with a cure for many of his troubles inside the service-pipes. If he went to Hastings, no matter what they made their gas of, he would find no trouble from internal corrosion—not to the last inch of iron pipe. He wanted to give the author confidence in the application of the cures, of which there were several, which could be resorted to under the circumstances of different gas-works; so that he could both cure the naphthalene and prevent corrosion inside the service-pipes.

Mr. M'LEOD, in reply to Mr. Vass, said while he had asserted that there was no remedy for corrosion of service-pipes, it was to be understood that he meant there was a remedy for everything provided they were willing to pay for it. If they did not choose to pay for it, but preferred to go on working in the way they were doing, there was no remedy; and he was right to this extent. One could quite follow what Mr. Glover said, that the adding of some oily matter to the gas would prevent corrosion of the service-pipes. His experience of naphthalene had been a short one; but it had been fairly extensive when it did come, because he dealt with something like 800 stoppages during the autumn of last year. He was also in the position of the foreman that Mr. Bloor talked about, because he had been some seventeen years in the gas industry before he met with naphthalene to any extent.

The PRESIDENT said the discussion had not been a long one; but it had helped to bring out some of the points that perhaps required clearing up.

ASPECTS OF GAS SUPPLY IN A SOUTH AMERICAN CITY.

By BERNARD F. BROWNE, of London.

The writer ventures to bring to the notice of the Institution some of the somewhat special requirements of the supply of gas, both in manufacture and distribution, in a South American city with a population composed of representatives of practically every nation upon the earth, and with, generally speaking, the low standard of education found among the classes offering themselves for employment in the labour market and for domestic service.

I.—LABOUR.

(*a*) *Labour Supply in the Argentine, and Governing Conditions.*—The writer refers particularly to the city of Buenos Aires in the Argentine Republic, where, owing to the constant and insatiable demand for labour of every description in the development of that country's marvellous natural resources, it is impossible to retain able-bodied men in the cities (where living is dear, owing to excessive taxation) except by paying exorbitant remuneration, which even then does not, in the long run, compensate an ambitious and industrious man for the lost possibilities of prosperity from working the land, either for himself or on behalf of other people.

(*b*) *Predominance of the Latin Artisan, and the Reason.*—The country to which the writer refers is especially suitable for the Latin races, on account of climate and language, and the Latin's ability to endure hardship and willingness to exist on the very simplest of diets. As a general rule he comes to South America alone, and is therefore at liberty to transfer himself just wherever he can sell his services to the best advantage.

(*c*) *Migratory Nature of Available Labour.*—This liberty, combined with frugality, industry, and high rates of remuneration, enables him to make a trip to Europe every two or three years—in many cases yearly, in fact—with the security that, owing to the constantly increasing demand for labour, he will immediately re-obtain employment on his return. The writer hopes that he will have made it clear therefore that the gas manager under these circumstances can never count on having the same staff from month to month, and must therefore be constantly breaking-in men for the various requirements of the undertaking, to fill up vacancies.

As a general rule, it may be said that the gas undertaking

has to teach every one of its men his trade, as the vast majority of employable men offering themselves for employment have never worked anywhere in Europe except on the land.

(*d*) *Degree of Education; Tendency to Labour Agitation and its Solidarity in this Direction.*—As an additional complication, there is the extreme credulity of the Latin and the ease with which even the best-hearted men are led away by the plausible arguments of the labour agitator, with the result that, even when it would seem that one's staff is contented and loyal and everything working harmoniously, one may be plunged in the midst of a serious strike, not on account of any substantial grievance, but just out of a spirit of unity with some other branch of industry which has a grievance to air.

(*e*) *Necessity of Means to Ensure Continuity of Gas Supply.*—During these times, intimidation is carried to a very fine art, and has to be seriously reckoned with. In the foregoing remarks, the writer's endeavour has been to show that a gas manager in South America is called upon to adopt many devices so as to cope with labour agitation—ignorant, though willing, workmen, a constantly changing working staff, and, finally, with an unpractical gas consumer with inefficient domestic service. It is necessary that these considerations should be kept in mind before unduly condemning some of the suggestions which the writer is about to offer as having given excellent results in his own experience, and many of which he would have no hesitation in adopting in this country had he the opportunity, owing to their tendency to facilitate a manager's control of the undertaking, and to ensure final satisfaction to the consumer who is willing to pay for value received. While the writer proposes to treat chiefly aspects of distribution, he would like to make a few references to points in connection with manufacture, as necessary adjuncts to ensure continuity of supply in view of the conditions of the labour market previously referred to.

(*f*) *Disadvantages under which the Gas Industry Labours in a Semi-Tropical Country.*—It should be mentioned that the operations of the Company whom the writer had the honour to represent were conducted in competition with two other gas companies, and, incidentally, an electrical monopoly, whose tariffs competed with gas on practically equal terms as to illuminating value. In addition, there was to be reckoned with the disadvantage under which gas labours in a tropical country, owing to the heat generated by the incandescent burner, and the refusal of an electrical monopoly to supply current for ventilating fans (an indispensable necessity) at the power tariff, unless current was taken also for lighting. With these preliminary observations, he will proceed to refer to one or two points in connection with manufacture.

II.—Prime Materials.

(*a*) *Coal Supply and Influence on Dividends of Fluctuations in Freight Market.*—The dividends of a gas undertaking dependent upon sea-borne coal, and a concession which fixes the price which it may charge for gas, are largely affected by fluctuations of the freight market in a country such as the Argentine, where the only return cargo of any importance is grain. When the harvest is plentiful, steamers will bring coal out cheaply, and *vice versâ*, as they must pay expenses over the round voyage. The average freights paid for coals during a period of nine years were as follows:—

1901	14s. 1d. per ton	1906	13s. 2d. per ton
1902	10s. 6d. ,,	1907	14s. 2d. ,,
1903	8s. 6d. ,,	1908	9s. 8d. ,,
1904	7s. 5d. ,,	1909	9s. 4d. ,,
1905	7s. 9d. ,,		

With such fluctuations, it becomes imperative to stock large quantities of coal when freights are low, and one's works are liable to become congested in consequence.

(*b*) *Spontaneous Combustion of Sea-borne Coal.*—For this reason, one is seldom free from coal fires, which usually seem to occur when extra labour is unobtainable; and it is not unusual for the coal to be already fermenting when it leaves the ship. Although the writer believes it to be contrary to accepted principle, he has found that the only efficient remedy for hot coals is to thoroughly swamp them with water. The method employed was to pump water from the gasholder tanks at 30 lbs. pressure through the coal, and then drain it back from the coal-stores through a settling tank.

(*c*) *Handling of Materials apart from Machinery.*—In every gas-works there are many instances where the man with the barrow is preferred to machinery, where the intermittent nature of the work or the standard of labour available does not render machinery advisable, or for structural reasons machinery is impracticable. The man with the barrow, however, usually requires a lot of looking after; and as for several of the reasons mentioned machinery was barred, there was installed all over the works a continuous system of "slung" joists carrying a tip-bucket on a ball-bearing carriage running in the joist. This could handle, as occasion required, coals from the yard or store to the bunker elevator, coke from the retort-house to the water-gas plant or yard, oxide to and from purifiers, or materials to and from workshops and stores by merely pushing the load.

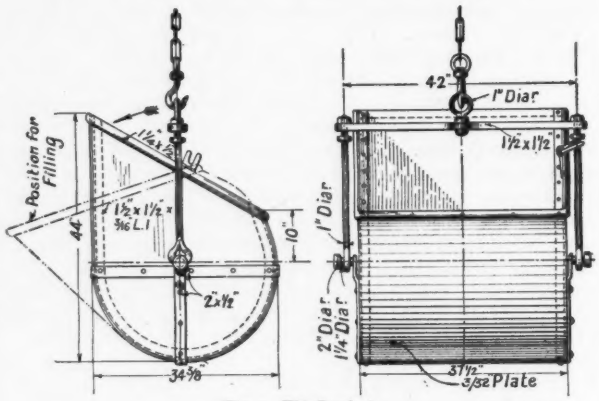


Fig. 1—Tip-Bucket.

The system is well known, and can be very simply applied with comparatively little skill. An illustration (fig. 1) is given of the bucket employed for the purpose, as also a sketch (fig. 2) of its application to the "sunk" purifiers.

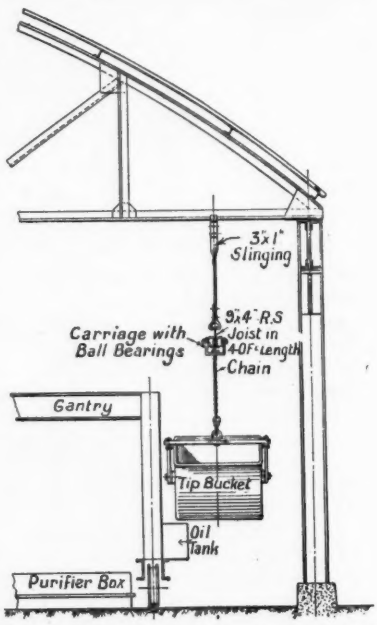


Fig. 2—Tip-Bucket on Slung-Joist, as Applied to Purifiers.

III.—Manufacture.

(*a*) *Retort-House Practice in Maintenance of Carbonizing Heats.*—In the retort-house, to ensure the maintenance of good carbonizing heats, the following method was employed. Having decided upon a convenient degree of draught which should always be available in excess in the main flue, the benches are worked (from the time they are lighted up clean, and have had the initial adjustments made to their respective dampers to bring them up to working heat) on the system of constant draught in the main flue. On this plan, it is found that individual dampers once set have practically never to be touched. If a bench gets cool, it is a sure sign that it is getting dusty. It is preferable to have a recording draught gauge on the main flue of each battery.

(*b*) *Disturbing Factors in Same and their Remedy.*—It is found that draught varies a good deal with the weather; and so for adjustment purposes it is convenient to have a few nostrils or ports in one's main flue damper to the chimney

which can be covered or uncovered with a loose brick as occasion requires. On receiving a cargo of inferior coal, for instance, it is a simple matter to slightly increase the draught on a whole battery at a time, and reduce it again as easily, without interfering with individual bench adjustments. This arrangement is particularly convenient for slow firing, and in the writer's own case has proved its efficacy during periods of labour troubles when stoking and firing were very much below the mark. It is convenient to primarily fix a degree of draught which will permit of bench dampers being opened to 75 per cent. of their maximum, more or less. The writer's own preference as regards bench dampers is to make the port as narrow as possible—say, 3 inches—and to get the necessary passage area by increased length, as on wide ports a very slight movement of damper makes a considerable variation of passage area, and consequently in the heat of the bench. With the object of keeping bench fronts free from air leakage, the writer has found it a good practice to periodically wash them over with liquid mud, and apply a couple of coats of tar over this. He also finds that this tends to reduce radiation, in default of special material for the purpose, and that if the process is once started, the stokers will carry it out themselves for their own comfort.

(*c*) *Safeguarding Retort-House Governors.*—Where retort-house governors are in use, it was found convenient to have an automatic valve in the foul main between the governor and the hydraulic. This may for convenience be a hinged aluminium or other light cover plate on a machined seat (such as is employed in the blast pipe of a carburetted water-gas plant), which tends to keep tight while there is a vacuum below it, but which can be weighted to discharge foul gas when a pressure of 4 inches to 6 inches occurs in the foul main. If, therefore, one's exhauster shuts down for any cause, intentional or otherwise, the governors will not blow their seals.

(*d*) *Steam Production with Waste Gases and Automatic Water Feed.*—Steam production in the retort-house by means of waste gases has been held to be fraught with danger by some engineers, since, unless specially attended, it is no one's particular business to see that the water level is properly maintained. The writer has been confronted with this difficulty, which is a very serious one in times of labour troubles.

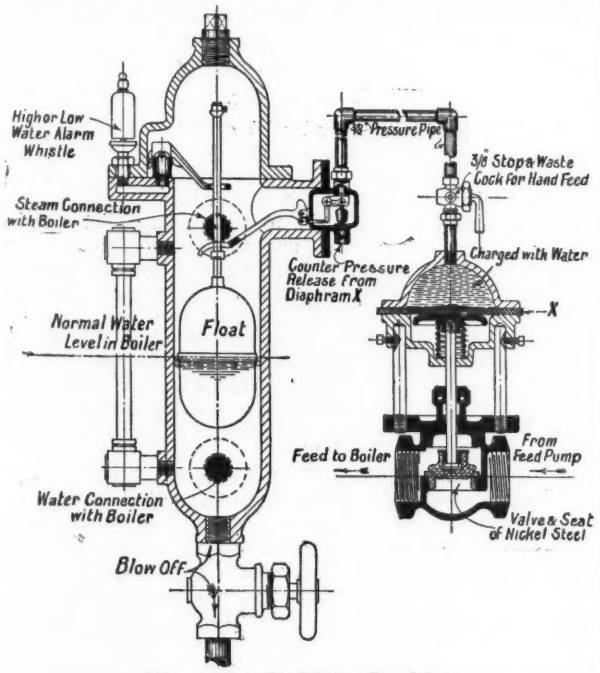


Fig. 3—Safety Feed-Water Regulator.

His boilers were of the annular vertical type with the hot gases passing up the inside and down the outside. All dampers consisted of tiles on flat surfaces to ensure tightness should a boiler be out of action, and close adjustment of steam supply when working. The difficulty of water feed can be absolutely eliminated by the use of the safety feed water regulator, which automatically maintains a water level within a limit of 1 inch. A sketch of this regulator is given in fig. 3.

(*e*) *Dimensions of a Boiler in Relation to Waste Gases.*—The dimensions of the boilers were 26 ft. 6 in. high by 8 feet external diameter, with concentric flue, 5 ft. 3 in. diameter by 20 feet high. The total heating surface of a boiler was 1100 square feet, and the water content 13¾ tons. Each boiler was served by the waste gases from the regenerative settings capable of producing a million cubic feet per diem, and produced sufficient steam at 75 lbs. pressure to serve exhausters and pumps for two million cubic feet. They gave absolutely no trouble.

(*f*) *Use of Carborundum to Enhance Refractoriness and Use of Retort Carbon as a Stand-By for Water-Gas Manufacture.*—The use of carborundum was found to be of considerable efficacy on new work in prolonging the life of combustion chambers and producer linings. The practice was to apply with a brush three coats of a proportion of 75 per cent. carborundum powder with 25 per cent. water glass as a carrier, diluted as might be necessary with water. On heating up the fire-work, the water glass fuses and the carborundum lining becomes a glass-like flux on the surface of the work, and is very refractory. It was also found to be highly beneficial to the lining of the water-gas generators. It was the writer's practice to reserve all retort carbon for gas-making purposes; and as a constant preparation for labour troubles, a considerable quantity was kept bagged on the operating stage of the water-gas plant. Its great advantage in time of trouble is the absolute absence of clinker in its combustion, and the feasibility of working continuously for a week if necessary on this fuel without cleaning the fires.

(*g*) *Blast Pressure in Water-Gas Generators.*—Carbon requires considerably less blast pressure—namely, about 13 inches water-gauge; and longer runs may advantageously be made than with coke as a fuel, as the former appears to store more heat during the process of blowing. It cannot be used conjointly with coke; and when changing over from coke to carbon, time must be allowed for the consumption of the coke already in the generator before the blast pressure is reduced. Using coke as a fuel, an appreciable saving can be made by the use of a high blast pressure, which appears to give a higher velocity in the fuel bed and result in a larger production of carbonic acid during the blast. This means that more of the heat of combustion is retained in the fuel bed, where it is most needed, rather than in the carburettor and superheater, where there is invariably an excess. The safety feed water regulator maintaining a constant water level, previously referred to, has been found to be of considerable benefit on boilers generating steam for the manufacture of water gas, ensuring steam of constant pressure and dryness, and as an economizer of boiler fuel.

(*h*) *Attention to Pumps.*—A distinct advantage was obtained by placing all pumps at such a level that the liquid handled could flow by gravitation to the pump, where this was practicable. Where impracticable, it is preferable to have suctions in duplicate. Where these precautions are taken, attention to pumps is reduced to a minimum.

(*i*) *Utility of Cycle Recorders for Positive and Negative Pressure.*—Personally, the writer is an advocate of the use of cycle pressure recorders, not only in connection with water-gas manufacture, but also at the principal stages of coal-gas manufacture, and on the inlet to governors. One is thus enabled to immediately trace cause and effect of anything abnormal, and to localize the exact time and place of its occurrence. On one occasion, these cycle records were accepted as evidence in the public inquiry into the death of a bricklayer on the water-gas plant—his family maintaining that he was suffocated, while the record proved that the water-gas plant was not making gas at the time. The cycle recorder also indicates improper attention to syphons.

(*j*) *Employment of Portable Vacuum Chamber for Emptying Syphons and Kindred Purposes.*—In default of a special installation for centralizing all syphons by connecting them to a vacuum chamber, these are very likely to get inefficiently pumped by a man strange to the job. For this purpose, a portable aspirator or vacuum chamber was employed (a sketch of which is shown in fig. 4) in which a vacuum of 23 inches of mercury was obtained by exploding a small charge of petrol. The vacuum produced by the rapid cooling of the one-tenth of the original air which now remains in the chamber will last for hours, and may be used gradually; one explosion being sufficient for a number of syphons. [As one of the many additional applications of such a portable apparatus, one may mention that of prompt evacuation of trenches and foundations in bad weather, both on the works and in the street.] The necessity for some of the foregoing precautions will be better appreciated when the writer mentions that it was his lot, during the first four

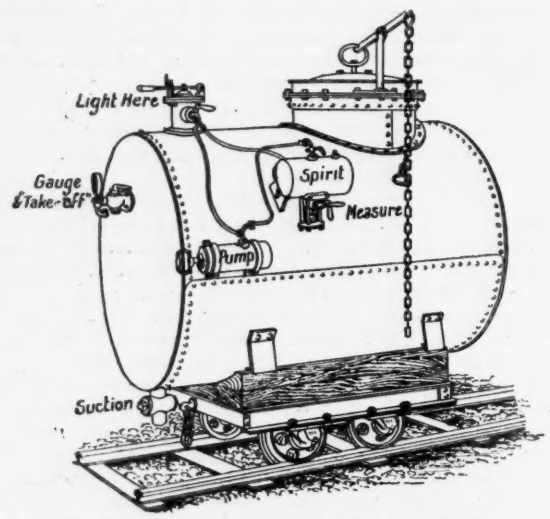


Fig. 4—One of Many Possible Forms of Portable Aspirators (Wegner's).

years of his residence in the Argentine, to see the staff leave the works in a body on three separate occasions.

IV.—Residuals.

(*a*) *Sale of Coke and Want of Accommodation in Modern Dwellings.*—As regards the sale of coke, many people have never tried coke as a domestic fuel. One very general difficulty is that in buildings of flats there is often practically no provision at all for fuel storage. Obviously under such circumstances it is no use to expect to do business at the usual rate of not selling less than half-a-ton at a time.

(*b*) *Evolution of Regular Daily Demand by Means of the Coupon System.*—With this in view, a system was initiated of coke delivery to private consumers in sewn jute bags of such capacity as to give about thirty bags to the ton. Cheques of ten coupons were sold in the branch offices; and the distributor would, at his weekly call on the purchaser, exchange bags of coke for an equivalent number of coupons. The bag remains with the consumer, and to encourage the return of the bags to the distributor, the latter exchanges a bag of coke for a certain number of empties in good condition—this number, of course, depending on the class of bag used and its initial cost. The growth of this business, and the fact that gas consumers having once tried the system continued it, made it advisable to start a card system in the coke office, dealing exclusively with the coupon trade. Thus clerical work was reduced to a minimum, different districts were served on different days of the week, and the distributor only required a list of his customers, and was required to do no clerical work. The branch office effecting the sale would forward to the coke office a counterfoil torn from the coupon cheque.

(*c*) *Tar Disposal; Long Distance Tar Pumping at High Pressure, and the Means Adopted for Eliminating its Attendant Troubles.*—Tar disposal on a remunerative scale was, in the early days of gas supply in Buenos Aires, a difficult matter; and although the glass manufacturers would take large quantities for use as fuel, the price they were willing to pay was not in proportion to its fuel value. Later on a demand for pitch developed for paving operations; and it was decided to instal tar-works. Due to various adverse circumstances, it became necessary to build these works at a distance of approximately four-and-a-half miles from the gas plant. It was therefore decided to attempt to pump the tar this distance. The pipe line consisted chiefly of 4-inch cast-iron pipes, with about half-a-mile of 8-inch and 6-inch mains at the gas-works end. The first experiences in pumping were disastrous, resulting in constant rupture of pipes, and consequent flooding of the surrounding neighbourhood with tar. The tar, by itself, obviously then could not be pumped under existing conditions. Attempts therefore were made to dilute it with liquor. For this purpose, the tar to be pumped was gradually transferred by gravitation to a small tank wherein was stored the liquor used for constant circulation in the hydraulic mains, and it thereby attained a considerable temperature (about 120° Fahr.). The pump—belt-driven, through gearing—was fitted with a relief valve on the delivery side, which discharged into the suction when the pressure on the pipe line exceeded 90 lbs. per square inch. The pump suction was fed by gravitation from a small visible reservoir into which flowed two equal streams—one being the heated tar referred to, and the other the hot liquor from the hydraulic main circulation. After this was resorted to, no further trouble was experienced with the pipe line, even in the coldest weather. Tar-pumps are invariably troublesome, and the convenience of an intermediate reservoir in tar transference from underground tanks to elevated ones in gas or tar works should not be lost sight of, although two pumps are required for the purpose (or one in tandem), since the attendant is able to judge the amount of tar passing and note deficiencies without loss of time, which has a tendency to avoid many incidental troubles which every gas engineer will have experienced with his tar-wells at one time or another.

(*d*) *Tar Dehydration and the Utilization of the Condensates.*—Dehydration of tar is being urged upon us as a condition of its employment for road surfacing; and as many undertakings will probably dehydrate in the near future, without proceeding further with the distillation of their tar, the following figures may be of interest to some. The custom was to extract the benzol from the light oils obtained from dehydration, and use it in the motor lorries as a substitute for petrol. The writer finds that, roughly, 2¼ per cent. by volume of the tar dehydrated was removed from the condenser and passed into the benzol still, where it gave, roughly, 25 per cent. of its volume in benzol, or (say) half-a-gallon per 100 gallons of tar. An application for the remaining oils from this rectification and from the dehydration may be found in the production of a cheap disinfecting fluid, prepared from the following formula: Resin 16 per cent., fish oil 1 per cent., caustic soda solution of 1·25 density 6·5 per cent., and of the tar oils referred to 76·5 per cent. The resin is first melted in an iron receptacle; the fish oil is then added and stirred in; then the soda is added for saponification; and, lastly, the tar oils are slowly added during vigorous agitation. The heating agent is then removed, and the contents of the vessel allowed to cool. The fluid thus obtained is of a dark colour, and is used in the proportion of 1 to 60 of water. The addition of the water to the fluid produces a milky white emulsion, which is homogeneous, and more or less a permanent solution. This fluid finds a ready sale among one's customers for washing floors and domestic animals, flushing drains, and for the destruction of ants. As the phenol contained in the first runnings from heated tar is mostly real carbolic acid, this fluid is a powerful disinfectant, and has in solution (as employed) a strong carbolic odour.

V.—Control.

(*a*) *Influence of Protective Tariffs on Gas-Works Extensions and Gas Appliances.*—In a country so situated that three months or more pass between the time a spare part is ordered from Europe and its receipt at the gas-works, it was necessary to maintain a well-equipped workshop. Added to this was the high import duty on manufactured plant, which frequently made it cheaper to buy raw material and manufacture one's own plant. The general practice was to erect all additional plant with one's own staff, as experience had indicated, for example, that valuable knowledge was to be gained by one's own workmen and possible troubles in initial working anticipated by the erection of (say) a carburetted water-gas plant, a coal-handling plant, or stoking machinery, without assistance from the manufacturer.

(*b*) *Piecework in the Meter Shop.*—Thus also it came about that the manufacture of meters and cookers was undertaken, in addition to ordinary repair work; and in a country where meter tampering by the consumer is not unknown, it also enabled one to profit by such experiences, and endeavour to combat the expert gas thief, when producing new meters. However, it is difficult for the engineer to always afford the time to exercise the control which is desirable in such a department; and it is convenient to keep a card system wherein every meter in use has a registered number—preferably the rotation number of the testing office. An occasional glance at these cards enables one to pick out meters returned to shop with unreasonable frequency, and to locate the workman at fault. This makes piecework possible both for new work and repairs. The card used took fifty meters (twenty-five on each side), and provided for five entries to shop for each meter.

(*c*) *Getting the Sympathy of the Latin Workman.*—Anyone employing Latins must listen patiently to their grievances, for they generally think they have the hard end of it anyway. If he has good men, he must not fail to show that he

appreciates them, while, whatever may be the consequences, he does neither himself nor an employee justice by retaining any man who does not render prompt and cheerful obedience to his orders.

VI.—Distribution.

(*a*) *Utility of Return Pressure Pipes for Good Pressure Distribution to Consumers.*—As regards distribution, primarily the writer was fortunate in the possession of return pressure pipes on all trunk mains. When the main system was reorganized, each trunk pipe line was accompanied by a 2-inch wrought-iron service parallel to it, which was finally connected to the main at the point where the greatest drop of pressure was to be expected—namely, where the trunk supplied the branches. The works end of the service was connected to the bell of the corresponding trunk governor, so that variations of consumption on the branches were directly communicated to the governor bell, and the governor was, in fact, almost entirely automatic in its action. As proof of this, it may be mentioned that the pressure recorders in the eight branch offices would show practically a straight line during the whole twenty-four hours; it being the custom to give 2¼ inches pressure constantly to the consumer, except from 1 a.m. to 6 a.m. It should be mentioned that the 2-inch services referred to were jute wrapped, dipped in hot tar, and then in hot pitch before laying, when the sockets were finally pitched by hand. The same process was applied to all consumers' services—pitch-filled troughing being impracticable owing to climatical conditions.

(*b*) *Marking of Meters for Maintenance.*—The custom was to paint a small portion of the front of the consumer's meter with a distinctive colour year by year as the meters left the store; and by this means it was possible to call in meters periodically for overhaul with very little trouble, and to judge of the feasibility of a consumer's complaint of an erroneous meter.

(*c*) *Discounts for Heating Gas and Convenience of Monthly Gas Accounts.*—A considerable discount was allowed on all gas used as fuel; and on this account discount meters were employed in series with the main supply meter. The writer may say that thousands of these meters (of the rotary type) were in use with satisfactory results; the approximation to correct positive measurement being within 5 per cent. All gas accounts were rendered monthly—every meter as far as possible being read on the same day of each month. Rental clerks, collectors, and index-takers were thus kept continuously employed, and became very expert. Defective meters and fraudulent consumers were also much more easily controlled; while the salaried classes among the consumers were much more satisfied to pay for their gas monthly—an arrangement of considerable importance to a gas undertaking, as under it the consumer is likely to be more liberal in his consumption. Taking all things into consideration, the increased cost over quarterly accounts is very slight per 1000 cubic feet; and there is thereby a great reduction in the volume of complaints for excessive consumption.

(*d*) *Meter-Reading Method.*—When index-taking, it was the custom to leave in the meter-index cover a paper slip on which was printed an exact reproduction of the face of the index, both of the control meter and the discount meter, on which the index-taker marked the position of the index hands, with a note below of the resulting meter-reading. On the reverse side of the paper slip was an explanation, with a diagram showing how to test for escapes by reference to the unit-wheel of the index. In the case of a complaint for excessive consumption, it was easy for the company's official to examine the marked position of the index hands on the paper slip, and see at a glance whether or not the index-taker had made the usual decimal mistake in entering up the state.

(*e*) *Attention to Non-Registering Meters and their Elimination.*—The rental department supplied each branch monthly with returns showing the consumers who had apparently discontinued the use of gas. For this purpose, machine-numbered cards were used, which required returning to the rental department with an explanation written on the reverse side. If meters continued idle for three months after every effort had been made by the branch to secure continuance, the meter was removed, and a stamped coloured plate fixed stating that the meter would be replaced without charge, if the consumer wished to revert to the use of gas. This method was found to be very productive and thorough. It was the custom, as far as possible, to fit out the branches not only as show-rooms, but also as the centre of management in a particular district, of the manifold services required of a modern gas undertaking.

VII.—Attention to Consumers.

(*a*) *Attention to Consumers on the Branch-Office System.*—Each branch had its own record of every one of its consumers, and was responsible for their entire attention, canvassing, service-laying, installation and meter fixing, maintenance, &c. Each consumer had a card allotted to him, under his street number, and all details of his appliances, fittings, and piping appeared thereon, in the form shown in figs. 5 and 5A, and which was called the "Consumer's General Record Card." Separate men in uniform were kept for attention to all complaints.

(*b*) *Registration of Complaints.*—Complaints received by telephone, either direct or from the head office (notified by letter), were written-up as received on a form, which was stamped automatically with date and time. Once attended to, the details were entered up in a register kept for the purpose, and the date only noted on the consumer's general record card, together with the index-number of the consumer's letter, if any. It is sometimes convenient, as will be readily admitted, to confront consumers with these details and their own letters. Registration of complaints is also convenient for weeding-out unsatisfactory workmen.

(*c*) *Aspects of the Cooker Business and the Hire-Purchase System of Installation.*—There was at one time a general and prevalent idea in the gas industry that the main reason why some people do not use gas for cooking was the obstacle of first cost. If this reason be proper and sound, everybody in a town where gas cookers and stoves are free would immediately put in a gas-cooker; and yet in some towns where gas cookers have been even given away, there are not as many in use as where they have been sold. This fact is a proof that the main obstacle in putting gas cookers and stoves in use is not their first cost. The question of how to make people want cookers and stoves is largely one of opinion. The writer's view was that if the business was properly handled, it would be unnecessary and inadvisable to hire-out either cookers, stoves, geysers, or fittings, and that they could be placed on the hire-purchase system without any decrease in volume of trade. Experience proved the correctness of the theory in this case, with a consequent considerable reduction in floating capital expenditure. The method was to total up the cost of the cooker, geyser, or stove with 50 feet of the necessary piping, and divide it into thirty monthly payments, when it would finally become the property of the consumer. The following details were published for the different types of appliances: (*a*) Type number, (*b*) price with 50 feet of pipe, (*c*) amount of monthly payment, (*d*) amount payable on fixing the appliance—namely, three monthly payments in advance *plus* the excess of piping—and (*e*) cost per foot of necessary piping in excess.

(*d*) *Consumers' Agreements.*—A contract with the consumer is thereby involved; and let it be as devoid of legal phraseology as possible, and let each form be in duplicate, divisible through perforations, in order that the company's official may make it out in the act, and leave a signed carbon copy with the consumer, so that the business may be settled out of hand. Every business man or woman likes an exact duplicate of any binding document. Business is very often lost through time being allowed to pass while a contract is being prepared at the head office.

(*e*) *Cooker Maintenance.*—One regrets to have to admit that ninety out of every hundred cookers are neglected by domestic servants, originating complaints of "bad gas." So acute became this neglect, that one was obliged to inaugurate a travelling cooker cleaning gang, in uniform, with whom one undertook to clean and overhaul the consumers' cookers once a month on payment of a small monthly charge. It was found that this effectively increased consumption and reduced complaints enormously.

(*f*) *Want of Cooking Accommodation in Modern Dwellings and Introduction of the Combined Cooker.*—In the various campaigns of endeavour to make people want gas appliances for cooking, it was found that gas was getting effectively shut out from one very important class of consumer—namely, the flat-dweller. Kitchens are now built so small in flats that it is an impossibility to find room for a gas-cooker if a kitchener already exists. Landlords, it was found, would not instal the gas-cooker only, as they would not pledge their tenants to the gas "monopoly," owing to the ignor-

NAME of STREET.		Nº	Flat	Branch Office		Size of Service		Business or Family

METER	Size	Kind	Control or Auxly	Position	Open Air?	Locked Up?	Condition	Fixing?	OBSERVATIONS
Lighting									
Calefaction									

Internal Piping	Largest Diam.	Iron or Comp.ⁿ	Condition?	Compy's Work?	Complain?	Escapes?	Pressure?	OBSERVATIONS

Cookers	Type	Rotation Nº	Quantity	Position	Hire or Purchase	Maintained?	Ironer?	Pressure?	Paid Up?

Shop Lights only	Type	Nº Burners	Quantity	Hire Purchase or Private	Quantity Maintained	Paid Up?	OBSERVATIONS

Stoves	Type	Quantity	Complain?	Pressure?	Size of Pipe	Condition	On Discount?	Rotary or Positive Met.r

Fig. 5—Front of Consumer's General Record Card (Size, 8 inches by 5 inches).

Geysers	Bath, Kitchen or Hand Type	Maker	Quantity	Coy's or Prv.te	On Discount?	Rotary or Positive Mr	Pipe	Complain?

Fittings Residences only	Coy's or Private	Class of Burner	Maintained?	Quantity Burners	Type of Fitting	Quantity ditto.	Nº of Lt.s on Discount Meter

OBSERVATIONS _____

Date of Complaints _____

House old or new?	Nº of Floors	Particulars taken by?	Date	Card made out by?

Fig. 5a—Back of Consumer's General Record Card.

ance of the average domestic servant available, and on account of some people undoubtedly favouring indirect heating, such as is applied to the oven in the ordinary kitchener. With this to combat, the writer started making and fitting in new tenement buildings a combined cooker for use with solid fuel at one end and gas at the other. In some cases where the occupier desired to use gas but condemned the direct-flame method in the oven, the grate was modified to take gas-heated refractory ball-fuel, which gave the desired kitchen range heat circulation effect. It was found that these combined cookers would obtain as gas consumers even people who were violently prejudiced against gas. They had the gas and the coal, they were free as regards choice of servants, and not dependent upon a "monopoly."

(*g*) *Combined Lighting Fixtures in Connection with Electrical Competition.*—From this, it is a very easy stage to combined lighting fixtures. In the gas industry there has been a tendency to discourage the use of fittings which allow of either system being used. Any electric light fitting can be easily and effectively insulated. Obviously, competition with the electric light will be less acute if those employing electric illumination can at the same time retain fittings for use also with gas. This feature of having duplex fittings should, it was argued, appeal to companies supplying gas only. The live competition before one was the tungsten lamp with the prismatic reflector. How often are one's canvassers told in large business houses: "I cannot spoil the symmetry of my place by putting in your gas-lamps, in addition to my electric lights; and if I have gas only, people will think I am economizing!" The answer to these people is to offer to instal combined pendants with both gas and electric sockets in an artistic combination. It has been found that such a customer becomes a good gas consumer. Such fittings were installed on hire-purchase agreements (six monthly payments), and prismatic glassware was supplied for the electric sockets, as well as the gas-burners, but no glow lamps. The fitting should be united to the gas-pipe through an insulated union joint, the end of both threads being embedded in the insulating material. The insulated cable fitted by manufacturers of duplex fittings should be left to the electrician to connect to the wiring. That is no part of a gas business.

(*h*) *Utility of Illumination Calculations for Canvassers' Use.*—It has been suggested that gas-fixture manufacturers should supply polar distribution curves showing the illumination given by the fixtures at various angles. The average canvasser would find some difficulty in applying these. The Welsbach Company of America have gone one better, and supply, for canvassers' use in connection with each of their different fixtures, tables deduced from the polar curves, showing the illumination values on each horizontal plane (at various heights to mantles from 4 feet to 16 feet at all points in even distances from immediately below the fixture to 20 feet distant). The working horizontal plane is the surface assumed in which the illumination is required—ordinarily about 2 ft. 6 in. above the floor. Allowing that a variation of 30 per cent. is within the specification of uniform illumination, it is quite easy to determine at what distance from the fixture the intensity is half this minimum; and this will indicate half the desirable distance between fixtures. By working this out for different heights from plane to mantles, the most effective height is seen at a glance. The Company referred to state

that satisfactory illumination requires the following intensities for various classes of lighting; and the writer has utilized their figures and calculations with excellent results.

—	Class of Service.	Illumination in Foot Candles.	
		Minimum.	Maximum.
1	Store rooms and warehouses	0·5	1·5
2	Corridors	0·5	1·5
3	Auditoriums	1	3
4	Residences and reading rooms	1	3
5	Churches	1·5	3
6	Stores, light goods	1	3
7	Stores, medium and dark goods	4	7
8	Clothing stores	4	7
9	Drafting rooms	5	10
10	Detail work tables	5	15
11	Show windows	10	50

Obviously, the mere statement of the candle power of a source does not mean anything unless qualified by a statement of direction. The foot-candle is taken as the illumination produced by a standard candle on a normal surface at one foot distant; and it is this illumination which is affected by the distance from the source of light.

(*i*) *Charging for Incandescent Maintenance.*—The lighting in business houses is always more or less on view, but that of a private house is more often than not at the mercy of inexperienced persons; and undoubtedly this very privacy has been the cause of ignorance on the part of a gas undertaking of uneconomical lighting, and the consequent loss of clients who have installed electric light. Fully one-half of consumers' complaints proceed from their inability to adjust or maintain incandescent gas-lights. Doubtless any scheme of maintenance must depend on the co-operation and good feeling of the consumer. This is very easily attained generally, seeing that all the consumer wants is a good light and avoidance of trouble.

When finally adopting an inclusive system for private house maintenance, it was decided to make the charge in the form of an additional 6d. per 1000 cubic feet on gas used for lighting, with a minimum charge of 1s. 3d. per month. It mattered not whether the consumer had five burners or fifty, they were all maintained at this price per 1000 cubic feet consumed. After prolonged experience with this method, it was found that, generally speaking, the dissatisfied consumer complains not of price but of value. This business was not self-supporting, but was an absolute necessity, if one was to maintain a hold upon the private lighting, in view of the inducements held out by the Electric Lighting Company. The first year's private maintenance business only returned 50 per cent. of its cost. The second year, however, returned nearly 70 per cent., due partly to improved organization, but chiefly to increase in volume of work undertaken. It should be mentioned that at the first overhaul of a consumer's burners, the materials used are charged for separately. It should be noted that during the second year the men were paid a bonus of 25 per cent. of the value of all mantles saved over a fixed allowance of 30 per 100 burners maintained, provided there were no complaints. Each man served from 1200 to 1500 burners.

(*j*) *Incandescent Maintenance Control in Private Houses.*—It was the custom to supply each customer with a canvas-backed folder card ruled for the twelve months, to last two years, in which the consumption of material was noted by the attendant at each visit. The book he carried was similarly ruled—the attendant himself signed the consumer's card, and the consumer signed his book. This card method was found to be very efficient in controlling complaints and inspection. For the sake of clearness, the card and a quarter section of a page taken from the attendant's book are reproduced in figs. 6 and 6A, as also the card used by the branch office (fig. 6B), to enter up every night the consumption of mantles for each workman from his maintenance book. The card lasts a month; and it is from this that his bonus is calculated by the stores department. The books were of the loose-leaf type, allowing of the addi-

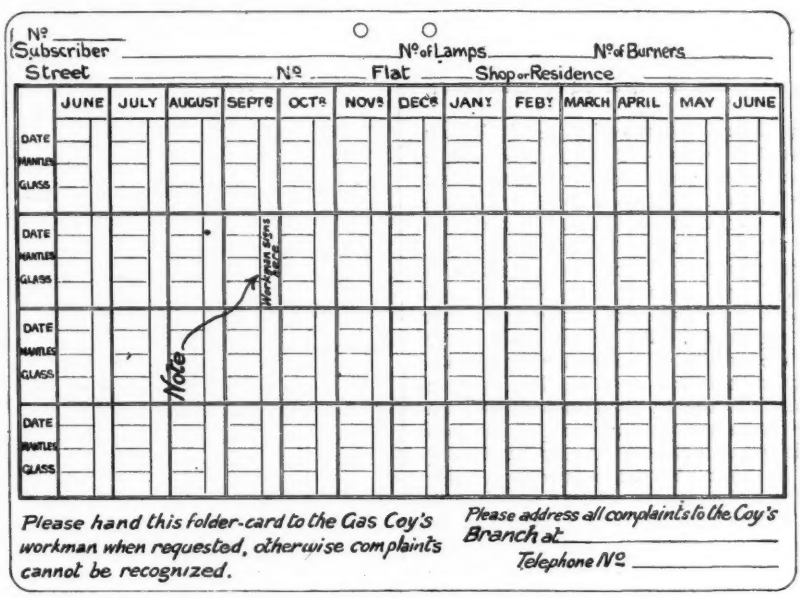


Fig. 6—Subscriber's Folder-Card for Incandescent Maintenance (Size when folded, 6½ inches by 4½ inches).

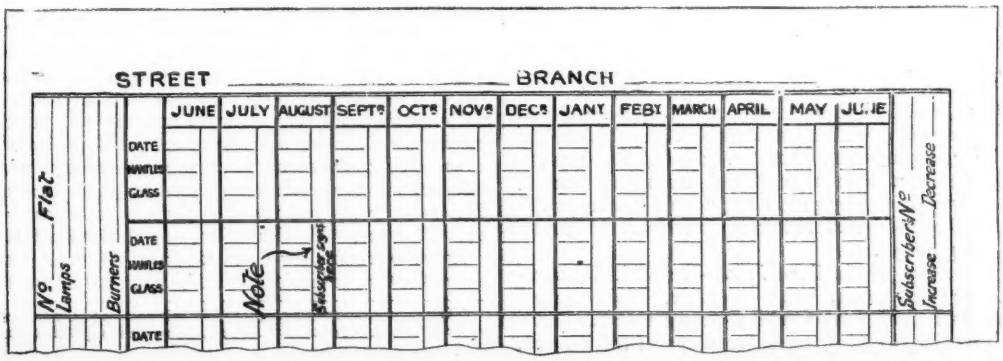


Fig. 6A—Attendant's Book for Incandescent Maintenance (Size of Page, 12 inches by 11½ inches—both sides alike).

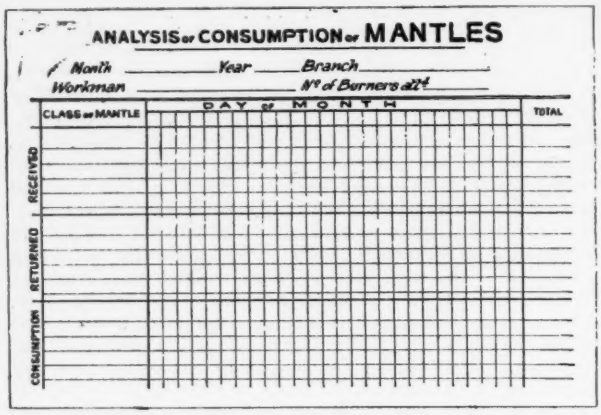


Fig. 6b—Branch Analysis Card for Incandescent Maintenance (Size, 8 inches by 5 inches. Reverse side ruled similarly for "Glassware").

tion of extra leaves as required by additional subscribers in any strect. The attendant wears a uniform, paying half its cost. New uniforms are provided half-yearly.

VIII.—Installing Gas Appliances.

(*a*) *Method in Carrying-out Installation Work for the Consumer.*—In carrying out all installation work, the general stores department was the place about which all arrangements centred. Primarily the branch office inspector consulted with the consumer, met him if necessary at the branch showroom, and made a list of all materials required for the job. He would then make out three copies of the specification, the original being his own work book, and the other two, carbon copies of the same, on special forms. The first carbon copy was a pink sheet, 8 in. by 5 in., marked "Delivery Note;" the second a card of equal size, with a printed heading indicating whether services, meters, cookers, stoves, geysers, or fittings were being treated of. The reverse side of the card was ruled to eventually show material which might be in excess, the number of hours occupied by the workmen, their names, and the date of commencement and conclusion.

(*b*) *Relation between Branch Offices and General Stores in Connection with Installation Work.*—The two carbon copies were then forwarded to the general stores department, where they were stamped with their rotation number. The cost clerk then made out a special machine-numbered account form which was primarily the quotation for the job, and secondarily the account which would be rendered when the job might be finished. These account forms were in duplicate, the second of the same number being the blank sheet receiving the carbon impression. The latter was a fixture in the cheque book, while the original account was perforated for detachment. Delivery note and card were then "pigeonholed" in the stores, while the "quotation-account" was sent by post to the consumer with a stamped envelope enclosed. Once back again in the cost clerk's hands, duly signed by consumer, the work was put in hand by sending out the goods, with the delivery note referred to—the consumer signing same. Returned by goods distributor, this note was then passed on to the branch foreman concerned, so that workmen might be sent along. Once the job was finished, the delivery note went back again to the stores, with the details of time occupied, &c., noted on the reverse side. The stores meanwhile always retained the card duplicate with the rotation number thereon, so that track of the goods sent out could never be lost. This was written-up from the returned delivery note, and filed for further treatment at the accountant's hands. The "quotation-account," as signed by the consumer, was now given to the collector. No alteration was allowed in these forms; and if any amplification of the stipulated work was undertaken, this formed the subject of an "amplification account," although the workman could obtain additional material from the nearest branch emergency stores by producing a card signed by the consumer for the additional material, blanks of which he carried for the purpose.

(*c*) *Paving the Way for the Gas-Fitter.*—It should be mentioned that the inspector, when preparing the original delivery note and card, would rubber-stamp same in large letters in a margin provided, with the name of the branch, in addition to a | B | for barrow (if a service layer were required to precede the gas-fitter or iron barrel needed installing), or an | L ..... ft. | if a ladder were required, or | U | if the job were of great urgency. Thus the general stores department could see at a glance which foreman should receive the job first, and the gas-fitter what tools he required for the job. In addition, in the event of consultation between workman and inspector being advisable, the latter used the stamp | S U | —nameiy, "see undersigned."*

(*d*) *Maintenance of Stocks in Stores Department.*—On account of the long time which perforce elapsed between the ordering and receipt of goods from Europe, the general stores department and dependencies kept a simple card system in which every article stocked had a separate card, 6 in. by 4 in., ruled on both sides, to show respectively (*a*) date, (*b*) quantity received, (*c*) origin, (*d*) quantity sent out, (*e*) date, (*f*) destiny, (*g*) balance. So that as articles were sent out of store, the balance was automatically kept; and as soon as the permissible minimum stock was reached, an indent was made for a fresh supply. For all goods bought locally, a carbon duplicate of the official order was sent to the department requiring the goods, which returned the same to the chief storekeeper once the goods had been received. This tended to minimize delays and avoided enquiries. All hire-purchase agreements and "quotation-account duplicate" cheque books, when returned to the stores by the accountant, were filed according to rotation numbers in steel cabinets, with an auxiliary card index, in which every house had a separate card (by streets), on which was entered the rotation number of each and every agreement or installation account belonging to the particular premises. Thus it was a simple matter to turn up all documents relating to any particular consumer as occasion required.

(*e*) *Records of Service, Meter, and Cooker Fixing.*—For the control and record of services, meters, and cookers fixed, the stores department maintained a card system, which is reproduced in fig. 7, as "General Stores Control Card A." The

STREET				Nº	FLAT	BRANCH OFFICE		URBAN DISTRICT		
SUPPLY PIPE			SERVICE PIPE			COOKER		METER		
Diam	Yds to Main	Diam Main	Diam	Cock?	Length	Type	Nº	Nº	Position	Use

METER									
Kind	Size	Maker	Control or Annuity	Changed	Reading	Motive	Removed	Reading	Motive

Fig. 7—General Stores Department Control Card "A." (Size, 6 inches by 4 inches. Both sides alike.)

rental department, for a similar purpose, maintained two systems with rather more detail, shown as B. (fig. 8) and C. (fig. 9) respectively. These diagrams will, the writer thinks, explain themselves.

(*f*) *Workmen's Records.*—Owing to the factors to be reckoned with in the formation of the staff, previously mentioned, and the constant changes going on therein, it was found necessary to keep a record of every man employed, with details of his periods of service, his promotion, and conduct. This was necessary to avoid the re-employment of unsatisfactory elements, and was useful in selecting candidates for promotion as required by expansion of business. The card employed for this purpose is reproduced in figs. 10 and 10A as "Workman's General Record Card."

(*g*) *Opportunity for Gas Publicity.*—It was found that a very effective advertisement was obtainable by the distribu-

* The symbols actually employed in this case, and the forms shown in the appendix, were, of course, different; being their equivalents in the Spanish language.

SIZE?	MAKER REC? BY COY ON				MAKER'S
	BODY	KIND	SLOT?	TESTING OFFICE Nº	Nº

STREET	Nº	FLAT	BRANCH	CONTROL OR AUXLY	USE	POSITION	REVISION BOOK Nº

FIXED	REMOVED	READING	MOTIVE	DATE OF NOTIFICATION	CLERK	OBSERVATIONS

Fig. 8—Rental Department Control Card "B."
(Size, 6 inches by 4 inches. Both sides alike.)

C	Type of Cooker				COMPANY'S Nº

STREET	Nº	FLAT	BRANCH	AGREEMENT Nº	MONTH	YEAR	MAINTAINED	CONTROL OR AUXLY METER

PAYMENTS COMMENCED	PAYMENTS FINISHED	COY'S MATERIAL	FIXED	REMOVED	CLERK

Fig. 9—Rental Department Control Card "C."
(Size, 6 inches by 4 inches. Both sides alike. White card for simple hire; pink, for hire-purchase.)

tion of a gas almanac at the new year. This can be made as attractive as circumstances warrant, and preferably be of such artistic standard as to secure its retention by the consumer. The front of the date-block in this case assumed the form of a detachable postal card, on the reverse side of which was printed a suitable formula to enable the consumer, with very little trouble to himself, to denounce any defect in his supply or installation, or to solicit the attendance of an inspector. Each month's calendar had a footnote printed in colour, drawing attention to gas specialities, with special reference to the season and some corresponding recommendation to the consumer as to his nearest branch office, and the period at which he should make a request for his heating appliances to be overhauled, &c., &c. The manifold possibilities of the system will immediately occur to everyone. The writer may say that the first year of issue, a large number of the postal cards referred to were received at the branch offices, and many led to increase of business.

IX.—Business Expansion.

(*a*) *Cost of Attention to Consumers in Relation to Increased Output.*—It will probably be urged that these extra attentions to consumers involve a large increase in distribution costs. Unquestionably, they do. But the net result may be compared to the showman's remark, "What I lose on the swings, I get back on the roundabouts," since from the increased output resulting therefrom, at the end of the third year, while distribution costs only per 1000 had increased 5 per cent., manufacturing costs and general charges had decreased in proportion to the increased output; so that the net profit per 1000 cubic feet sold increased 4·6 per cent. The increased output in the case cited (a 600 million cubic feet undertaking) was as follows, previous years being given for the sake of comparison:

	Per Cent.		Per Cent.
1902	5·75	1907	10·57
1903	1·24	(6·2 per ct. light, 4·37 per ct. fuel)	
1904	4·69	1908	16·21
1905	4·26	(9·7 per ct. light, 6·5 per ct. fuel)	
1906	0·34	1909	8·9
		(4·35 per ct. light, 4·55 per ct. fuel)	
		1910	Absorption of other competing companies

Thus it will be seen that in the three years 1907 to 1909 inclusive, every 100 millions of previous output was increased to 139·9 millions, or (say) 40 per cent. increase in the gas sold. This entailed only an 8 per cent. increase in the capital account.

(*b*) *Competition between Gas Undertakings and their Would-be Rivals.*—Competition between gas undertakings is uneconomical; but competition between gas and electricity is a useless necessity. It will probably always exist to a greater or less degree, though it is, as a rule, wasteful of both energy and money. In the Argentine, the selling points of gas and electricity for lighting were generally so nearly balanced that it was almost entirely a matter of new business skill, perfection of general service, and consequent company popularity, as to which system would predominate in the competition.

Discussion.

Mr. Samuel Glover (St. Helens) wished to congratulate the author of the paper most heartily on the way in which he had put it together. He thought it would be gratifying to him that he had afforded the gas industry an example of how to give a *résumé* of his paper, when he told him that, notwithstanding he (Mr. Glover) had no idea of the principle which had been adopted, he had been able to follow every part of Mr. Browne's summary. They all heartily congratulated him on his experiences abroad. He assured him that, notwithstanding that many of these were peculiar to the places concerned, the paper would furnish matter for a good deal of thought, and would be one to which they would often refer.

Mr. F. J. Bywater (Birmingham) wished to add his meed of praise to the author. He had read the paper, and it had

NAME		NATIONALITY	DATE OF BIRTH	AGE AT ENTRY	STATE	INFIRMITY	ENTERED	LEFT

DATE	DEPARTMENT	FOREMAN	DISTRICT	EMPLOYMENT	CAPACITY	PAY Nº	WAGE	SALARY	PREMIUM	BONUS	ADDRESS

Fig. 10—Front of Workmen's General Record Card (Size, 8 inches by 5 inches).

OBSERVATIONS ON CONDUCT

DATE	INFORMATION	SOURCE	VERDICT	CHIEF'S INITIALS

Fig. 10a—Back of Workmen's General Record Card.

struck him as being a record of great ingenuity and resource; and one could quite believe that Mr. Browne had brought great intelligence and care to bear on the problems that had arisen in the new country to which he had gone. Those who at home were sometimes apt to complain about the hardness of their case, would feel great sympathy for Mr. Browne in the trials he had had to contend with; and they could not but agree that he had faced them with considerable success.

Mr. F. W. Cross (Lea Bridge), as one who had had an experience of some seven years in charge of Colonial gas-works, wished to add his congratulations to Mr. Browne upon the thoroughness of his paper, which he had read with great pleasure, and with a full appreciation of all the responsibilities and difficulties the author had had to contend with in the Argentine. His (Mr. Cross's) experience was that every day fresh troubles arose on the works; and with the customers they had to be got over immediately, without advice from anyone outside such as they were able to obtain in England. It certainly reflected great credit on Mr. Browne that he had met all difficulties in such a thorough manner. He could assure the members they would be well repaid by reading the paper, and studying it carefully.

Mr. C. F. Botley (Hastings) said he would be glad if Mr. Browne would give them further details. He should like to ask him whether, in connection with what he had stated, there had been any objection raised by the electricity supply authorities.

Mr. E. A. Harman (Huddersfield) said there was only one question that occurred to him to ask, and this was with regard to the reference to the sale of coke in small quantities. Mr. Browne's experience coincided very largely with that of many towns at home. He said in the paper, with regard to the sale of coke, that many people had never tried it as a domestic fuel. One very great difficulty was that in buildings consisting of flats there was often practically no provision for the storage of fuel. Obviously, under such circumstances, it was useless to expect to do business at the usual rate of not selling less than half-a-ton at a time. In Huddersfield, they had got it down to 1 cwt. quantities, and still people would not try it. Latterly they had tried a system of selling coke by the pennyworth; and this was about as low a figure as they could sell it at. They sold 12 lbs. of coke in a paper bag for 1d.; and as they were sending out many thousands of these, they hoped soon to popularize the sale of coke for domestic purposes.

Mr. Browne thanked the members for the way in which they had received his paper. He said he should almost have preferred if it had met with a little more criticism, because then he would have felt that he had written something which was worthy of being pulled to pieces. With regard to Mr. Botley's question, he might tell him that the electricity supply companies did not approve of the system. In reply to Mr. Harman's remarks on the coke question, he might say that he had copied the European system of distribution in paper bags; but it did not "take on." What he believed made the coupon system do so was the very great interest taken in lotteries in South America. Their coupons were very well expressed, and were fine examples of lithography work; and to this he thought he must attribute the popularity of the system.

The President said their thanks were due to Mr. Browne for his paper. Although it had come at the end of their session, he could assure him it was not the least, either in quantity or in quality. He had taken the opportunity of reading the paper through, and had found it very interesting indeed. He could bear out Mr. Browne in what he had said with regard to some of his experiences.

THE LECTURE.

SURFACE COMBUSTION AND ITS INDUSTRIAL APPLICATIONS.

By Professor W. A. BONE, D.Sc., Ph.D., F.R.S.

My chief object in appearing here to-night is not so much to discourse upon the nature and causes of surface combustion as to demonstrate experimentally some of its possible economic advantages and applications. The new system of burning gas which I shall have the honour of introducing to you to-night is as yet so much in its infancy that I cannot do more than indicate the fringe of its inherent possibilities. The rest I must leave to your imagination—that is to say, provided that I succeed in convincing you that there is anything at all in the new system.

By way of introduction to the more practical methods with which I shall deal presently, I wish to explain certain facts pertaining to surface combustion which differentiate it from the more familiar and perhaps better understood processes of gaseous combustion as they occur in ordinary flames. In the first place, I want you to understand that surface combustion is primarily due to the accelerating influence of hot surfaces upon chemical changes in gaseous systems. It may be laid down as a well-established principle that if at any temperature a gaseous system (*a*) tends to pass over into another system (*b*), then the mere contact with a solid at the same temperature will, as a rule, accelerate the process. To take a very simple example, if a mixture of hydrogen and oxygen in their combining proportions (electrolytic gas) be maintained in an enclosure with smooth glass walls at a temperature of (say) 450° C., there will certainly be a tendency to form steam; but the rate of change would be negligibly small—almost inappreciable. If, however, there be brought into the system some porous solid material at the same temperature, so that a large surface is exposed to the gases, the rate of change would at once be rapidly accelerated in the layer of gas immediately in contact with the hot surface. Steam, the product, would diffuse outwards from the surface, and the supplies of hydrogen and oxygen at the surface would be renewed by diffusion inwards. This combustion would proceed heterogeneously at the surface until the transformation of the original electrolytic gas into steam would be complete. In the case I have just cited, the rate of combustion, though now quite measurable, would probably be insufficient to cause any self-heating of the enclosure. The temperature would remain at 450° C., which is well below either the ignition temperature of the combustible mixture or the point at which a solid would attain even incipient incandescence.

But flameless surface combustion can be shown to occur in contact with an incandescent surface, as was discovered as long ago as 1816 by Sir Humphry Davy, during his memorable researches upon steam. He asked himself this question: Whether, seeing that the temperatures of flame far exceed those at which solids become incandescent, a metallic wire can be maintained at incandescence by a slow combination of two gases without actual flame. Davy immediately tried the effect of introducing a warm platinum wire into a mixture of coal gas and air rendered non-explosive by an excess of the combustible gas. The wire immediately became incandescent, and continued to glow, by reason of the flameless combustion of the gas at its surface, till the whole of the oxygen had disappeared. We must therefore distinguish between two conditions under which combustion may occur in an explosive gaseous mixture: (*a*) Homogeneity—that is to say, equally throughout the system as a whole at temperatures below the ignition-point slowly and without flame, and also at temperatures above the ignition-point rapidly and with flame; and (*b*) heterogeneity, or only in layers immediately in contact with a heated surface, as in surface combustion, which also may take place either above or below the ignition temperature. It is necessary to remember also that, *cæteris paribus*, the heterogeneous (surface) combustion is a faster process than the normal homogeneous combustion which takes place in an ordinary flame. Again, I would have you remember that the power of accelerating combustion is not peculiar to a few special classes of solids, such as metals of the platinum group, which were first investigated from this point of view. These, indeed, possess it in an eminent degree. But it is apparently common in various degrees to all solids alike; and at high temperatures any sufficiently refractory material may be used with effect. In this way it is possible to realize an intensive combustion at the surface of a hot solid, which, provided it be of a sufficiently refractory nature, may be raised to a high degree of incandescence, whereby a large proportion of the potential energy of the gaseous mixture may be directly transformed into radiant energy—a most important consideration in industrial heating operations.

My next contention, and one which leads right up to the main theme of my discourse, is that if hot solids possess, as they undoubtedly do, the power of accelerating gaseous combustion at temperatures below or in the neighbourhood of the ignition-point, the same power must also exist and be

manifested at higher temperatures, and even at such temperatures as prevail in ordinary flames. If this proposition be true, it follows that the immersion of a hot surface in an aërated flame must produce a region of accelerated combustion immediately in contact with the surface; and if the area of the surface in relation to the volume of the combining mixture be progressively increased, it is conceivable that the regions of accelerated combustion may be correspondingly enlarged—that the whole, or practically the whole, of the chemical change would occur within them. There would thus be realized my conception of "flameless incandescent surface combustion," which, albeit in its present form possibly an unattainable ideal, is, I shall hope to convince you, in very large measure practically realizable.

It may be of interest to consider for a moment to what extent it is possible to accelerate the process of combustion in ordinary flames. Our ordinary unit of time—the second—is so palpably gross compared with the immeasurably short interval between successive collisions in a gaseous medium (which, even at the ordinary temperature, must be computed in terms of thousandths of millionths of a second) that what seems to the eye to occur instantaneously may, after all, be extremely leisurely transactions when considered in terms of molecular time-units. Thus the total duration of chemical change in each successive layer of electrolytic gas undergoing ordinary explosive combustion in which the flame is propagated by conduction, is probably something of the order of 1-50th of a second, which is at least a hundred million times as great as the comparative interval between successive molecular collisions by electrolytic gas at the ordinary temperature. Combustion in ordinary flames must, therefore, be considered as an extremely slow process. But the rate of combustion of electrolytic gas may be accelerated up to a certain maximum, which is attained when each successive layer of the mixture is fired by adiabatic compression, as in detonation. In such circumstances, combustion is propagated with the maximum speed and intensity; and from the known ratio of explosion—viz., 2820 metres, or 1¾ miles, per second—my friend Mr. D. L. Chapman, of Oxford, has calculated that the temperature in the explosion wave is somewhere about 4265° C. Even under such intensive conditions, however, it may be shown that the actual duration of chemical change in each successive layer of the mixture is something of the order of 1-5000th or possibly 1-10,000th part of a second. But even this, which may seem to be absolutely instantaneous, is about a million times as long as the molecular time-interval. Such computations may appear to many present fanciful, if not fantastic. But if by their help I succeed in convincing you of the extreme slowness of combustion in ordinary flames, and the possibilities of its acceleration by suitable means, a useful purpose will have been effected.

Before passing on to the more experimental and practical part of my lecture, I would draw your attention to another important consideration which will serve to emphasize the difference between ordinary combustion in flames and surface combustion. In the course of my recent work on explosive combustion, I have proved experimentally that a hydrocarbon such as methane burns much faster than either hydrogen or carbon monoxide. The speed at which methane is initially oxidized under the conditions prevailing in ordinary flames is some twenty times faster than that at which either hydrogen or carbon monoxide is burnt. I have found that the introduction of a hot surface into such a system completely reverses this order of things; for while the surface doubtless accelerates the combustion of all gases, it appears to act in this sense to a large extent selectively—accelerating the combustion of certain gases much more than others. The fact that the mere introduction of a hot surface into a combining system will entirely alter the relative speeds of oxidation of hydrogen and methane is surely a most conclusive experimental proof of the reality of surface combustion.

I now propose to pass on to the experimental part of my lecture. Leaving the theoretical part of the subject, I shall proceed to demonstrate to you some of the applications of the two processes of incandescent surface combustion that have been evolved during an investigation in which I was associated with my colleague Mr. M'Court, and which have been carried out, as many of you know, at the works of Messrs. Wilsons and Mathiesons, at Leeds. The first method which I shall endeavour to demonstrate to you is what we call diaphragm heating. This diaphragm represents in a simple form the way in which diaphragm heating is carried out. We have on the lecture table here a diaphragm, in which the feeding chamber at the back of the diaphragm passes through a porous material a mixture of gas and air in their combining proportions—or rather a mixture containing a little more air than is required to completely burn the gas. This explosive mixture is caused to burn on the surface of the diaphragm, whereby it is quickly raised to a state of incandescence. When the incandescent state has been once obtained, the flame disappears, and the surface itself is maintained in a state of incandescence by the continued combustion of the gaseous mixture which is being passed through the diaphragm.

Section of Porous Diaphragm with Mixing-Chamber at Back.

Here you have one of our diaphragms actually in operation. It has been lighted up before your eyes; and we are rapidly approaching the condition of things whereby the ordinary combustion is being superseded by incandescent flameless surface combustion. The diaphragms, I may say, are composed of a refractory material—ordinary fire-brick crushed and meshed to a uniform size, and then agglomerated, by a special process which I need not here describe, into a solid form. The diaphragms are extremely porous. As a matter of fact, the pressure required to drive the gaseous mixture through the diaphragm is only ⅛ inch water-gauge. We have a water-gauge attached to the feeding chamber; and the gases are now being sent through the diaphragm at a pressure of only ⅛ inch water-gauge. There are two or three features about this diaphragm method to which I would draw your attention. In the first place, the combustion of the gases is confined to a very thin layer on the surface of the diaphragm. As a matter of fact, in the one burning before you this incandescence does not extend to more than a depth of about ⅛ inch below the external surface. The whole of the combustion takes place, therefore, within a very thin layer of material. In the second place, I would point out that the whole of the heat is being liberated at the surface. The back of the diaphragm is so cold that I can put my hand upon it. As a matter of fact, it is slightly colder than my hand. There is no heat generated in the case of the diaphragm. In the next place, the combustion of gas is absolutely perfect by this method. There is no unburnt gas escaping from the surface. The combustion is absolutely complete within the very thin layer that I have mentioned.

After this diaphragm has been on a little time, it will attain its maximum temperature. It is freely radiating out into the room; and, therefore, there comes a point when the amount radiated out is just balanced by the amount of heat generated on the surface of the diaphragm. We have here a pyrometer; and one of my assistants will focus it on the diaphragm. In a test we made a day or two ago, we found that the maximum temperature obtained when the diaphragm was freely radiating into a room was 850° C. If we were to reflect this radiation back on to the diaphragm by means of a surface placed in front of it, we should naturally increase the temperature of the surface; but with free radiation, we obtain a maximum temperature at an equilibrium of about 850° C.

My next experiment will illustrate another important point with regard to diaphragm heating. It is this. Since the mixture which is fed into the chamber at the back of the diaphragm contains more than sufficient oxygen to completely burn the gas, we are entirely independent, for the combustion of the gas, of the atmosphere outside the diaphragm. As a matter of fact, when one of these diaphragms is lighted up and its state of incandescence has been produced, this state of incandescence will be maintained, even though the diaphragm is plunged into an atmosphere which will not support ordinary combustion. We have here a simple diaphragm which we are now just lighting up. In the initial stage, you get a certain amount of flame. This will presently disappear. When we get the diaphragm into its proper state of incandescence, I shall plunge it into a chamber through which carbonic acid is being passed. Here is a chamber through which carbon dioxide is passing. I will adjust the supplies to this diaphragm to get the requisite degree of incandescence. [The incandescent diaphragm was then plunged in the chamber.] We can still further enhance the radiating capacity of such a diaphragm by placing in front of it a gauze of nickel. The

effect of the nickel gauze is that the radiation from the diaphragm is absorbed by the nickel gauze and is given out again at a different wave length. Also some of the sensible heat of the hot burner is absorbed by the nickel gauze. Therefore, not only is the total radiant effect increased, but the appearance of the diaphragm is somewhat changed, and the wave length of the radiation emitted is also changed; and for many purposes this is an effect which is more agreeable to the eye than is the effect from the diaphragm itself without the nickel gauze. I have on this table a small diaphragm in front of which is placed a nickel gauze. The effect is for the gauze to take up the radiation from the diaphragm, and emit a different wave length.

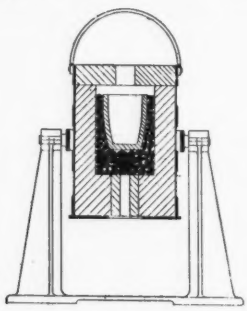
I propose to show you next what we hope will become an important application of diaphragm-heating in chemical industry—namely, for the evaporation and concentration of liquids. I may say at this point that there is one feature of the diaphragm which is very useful—namely, that it may be employed in any position, and at any desired angle. We can use it in any plane between the horizontal and the vertical. In this way, by using a diaphragm with its incandescent surface above the object to be heated, we are able to impart radiant energy to the surface of the object from a position above it. This application is important in the evaporation of liquids, because we are able, by this means, to evaporate liquids which could not be treated by any ordinary method by applying heat from below. For the purpose of illustration, I have taken a solution of sodium silicate, which is commonly known as water glass. This is a solution which cannot be evaporated at all when heated in a vessel by the flame from below; but by means of a diaphragm pouring radiant heat on to the surface, we are able to heat the surface of the liquid, and the solution is evaporated, a salt rises to the surface, it is dried by the radiant heat, and we are able to skim it off from the surface. In this way, we are able, not only to evaporate saline solutions, but we have succeeded in concentrating a dilute solution of glycerine, sulphuric acid, and many other liquids whose concentration in the ordinary way is a matter involving considerable time and difficulty. We are able to concentrate these solutions rapidly. During the concentration, it is only the surface layer of liquid which is being actually heated. The layers of liquid under the surface remain, comparatively speaking, cool.

Of the two processes of incandescent surface combustion with which I am more immediately concerned to-night, that of diaphragm heating, which I have just demonstrated, was the first to be discovered. We were led onwards to the second by logical experimental procedure, which I will now endeavour to illustrate to you. Of course, it was obvious in diaphragm heating that, where a diaphragm was to be placed in a horizontal plane, and was to throw heat upwards with its incandescent surface pointing upwards, there was no necessity in such a case to conglomerate into a coherent whole the particles composing the diaphragm. We found it would equally serve its purpose if we took material of fine grain and heaped it on one plate, at the bottom of which we supplied a mixture of gas and air in proper proportions.

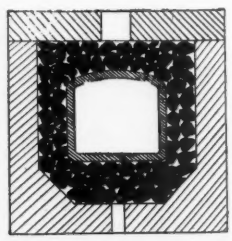
We have on a plate I have here granular material which has passed through a sieve containing 8 meshes to the lineal inch, but which will not pass through a sieve containing 16 meshes to the lineal inch. If we heap this material up on a plate into the bottom of which we introduce our gas and air mixture, and apply a light, the combustion of the gas is confined to the uppermost layers of the material. If I were to partly stop the radiation from this heap of material, combustion would gradually be propagated downwards through it, and it would leave the surface cool. You would get an incandescent layer somewhere down the material, and the outside layer would remain, comparatively speaking, cold. We found that if we gradually increased the size of the granules composing such a bed, the speed at which the combustion would travel inwards was increased till, by using granules that would pass through a sieve containing 2 meshes to the lineal inch, but not through a sieve containing 4 meshes, we got a material which, when we piled up a similar plate fed with gaseous mixture, the combustion immediately passed right down through the whole material. I will turn on the air gradually, and now the combustion is taking effect at the bottom and not at the top, and is gradually going upwards. What we have been demonstrating here is to endeavour to show you the difference, and yet the connection, between the two processes of incandescent surface combustion with which I am more immediately concerned to-night. Here you have what I may call the diaphragm conditions reproduced. You have the second process—viz., the injection into a bed of already incandescent material of coarse texture, at a high rate of speed, a mixture containing gas with rather more air than will completely burn it. In this way, what happens first is that with the mixture, when it is first lighted, the flame is produced; that flame starts back, and combustion occurs in the lower part of the bed. Very quickly the lower part is made to incandesce; and as it becomes incandescent, the flame gradually disappears, and surface combustion takes its place until we get to a condition in which we have probably 90 per cent. of the combustion taking place as surface combustion simply, and only a small proportion taking place under the condition of ordinary flame. When this comes to pass, the surface combustion spreads upwards till we are able to feed more and more gas, and complete the combustion in a comparatively small space and entirely by the surface combustion round the material composing the bed. This is, in principle, what we call our Process No. 2.

Now let me show you, by some lantern slides, some applications of it. The first is the process in its simple form. Here is the bed of material. This must be of a very refractory nature—in fact, the temperatures we can obtain by this method are so great that our difficulty has been to find a material sufficiently refractory to withstand the temperatures which are thus made possible. We use, by preference, calcined magnesite, which has been calcined at a very high temperature. This magnesia is one of the most refractory substances known. This is a bed of magnesia which will pass through a 2-inch but not a 4-inch mesh. Into this bed we bring, through one or two passages, a mixture of gas and air in their combining proportion. It is brought into the bed through a simple nozzle. The material in the neighbourhood of the points of entry of the mixture is made very quickly to incandesce; surface combustion supervenes, ordinary flame ceases, and then the surface combustion extends until the whole surface becomes incandescent. Where there is free radiation, the temperature is not so high as at the lower parts of the bed where there is no radiation.

The next slide shows how this may be applied to the heating of crucibles—the diagram being one of a small crucible furnace. The crucible is placed in, and surrounded by, a bed of the refractory material. Into this bed, through a passage at the bottom of the furnace, is fed a gaseous mixture, which burns under conditions of surface combustion. As the hot products pass each side of the crucible, the heat is communicated to the crucible very rapidly; and practically we are able to transmit as much heat to the contents of the crucible as would correspond to the maximum conductivity of the materials composing the walls of the crucible. It is heated entirely by radiant heat. We can, in a very few minutes, melt a charge of steel in such a crucible. We have experimented with furnaces of this size, and they will melt 2 cwt. or 3 cwt. of steel.



Arrangement for the Heating of a Crucible.

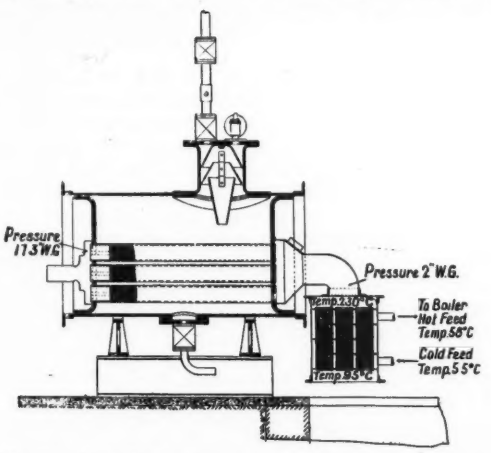


Arrangement for the Heating of a Muffle-Furnace.

The next slide shows the method adapted to the heating of muffle furnaces. A gaseous mixture is fed in through the passage at the bottom of the furnace; surface combustion takes place, and the products of combustion ascend round the crucible. In this way we can obtain temperatures which are very much above those at which any material forming the muffle could be fused. We have difficulty in getting makers to supply muffles which will stand the temperatures we are able to produce. Now we are easily able to obtain in a muffle a temperature of some-

thing like 1500° C. Above this temperature, of course, the muffle itself begins to be attacked, and its life would not be very long. But we could, if necessary, obtain a higher temperature. We are limited, so far as the practical temperatures are concerned, by the resistance to high temperature of the material composing the walls of our muffle. As an illustration of the very high temperatures we can obtain, I may say that at one stage of our work we used carborundum (carbide of silicum), which, as you know, is one of the most refractory materials. We thought we could not select a better thing for composing the bed of granular material in which the combustion was to take place; and it acted very well for a time. Here is an instance of the very high temperatures we can obtain. We found that the carbon of the carborundum was burnt; leaving behind the silicum burnt to silica. As a matter of fact, the mixture we injected into the bed contained a proportion of oxygen rather more than is required for the complete combustion of the gas; and in course of time the carborundum was wholly converted into silica. The temperature at which the carborundum is burnt to carbon dioxide of silica is known to be extremely high; it is somewhere in the neighbourhood of 2000° C. Therefore we can produce in this bed temperatures of something like 2000° C. if required.

I now wish to explain to you, somewhat in detail, an important application of surface combustion to steam-raising in multitubular boilers. We have on the table a small experimental boiler. It is well known that hitherto the gas-firing of steam-boilers has not been very successful from the point of view of thermal efficiency. There are two classes of gas which are largely used for steam-raising. One is blast-furnace gas, of which there is always a large surplus available from blast-furnace plants; and the other is the surplus gas obtained in the manufacture of coke. Coke-oven gas approximates very nearly to ordinary coal gas in point of view of composition and calorific power. It has been estimated by a prominent blast-furnace engineer that the efficiency of the best type of water-tube boiler fired by blast-furnace gas does not exceed something like 55 per cent.



Application of the Surface Combustion System to a Steam-Boiler.

From careful observation which was made on Lancashire boilers fired by such gas, evaporating water previously softened to within 4° of hardness, with an attachment of the most approved type of economizers, so that the temperature of the burnt gases going to the chimney was reduced to its lowest possible point consistent with good draught, it has been proved that the thermal efficiency does not exceed 60 per cent. This figure is probably somewhat higher than the average efficiency usually obtained with boilers fired with blast-furnace gas; and we may consider it is probably the maximum figure in relation to ordinary practice. With regard to boilers fired by coke-oven gas, I think one can fairly say that the average thermal efficiency of steam-raising does not exceed 65 per cent.; and that in exceptional cases it may amount to 70 per cent. It must therefore be confessed that the substitution of gas for raw coal in boiler firing has hitherto not been conducive to fuel economy; and, indeed, boilers are rarely gas-fired except when there are supplies of surplus gases which cannot well be utilized in any other way. But, on applying the principle of surface combustion to the gas-firing of multitubular boilers, we have been able to obtain a thermal efficiency corresponding to the transmission to the water in the boiler of nearly 95 per cent. of the energy possessed by the net calorific value of the gas.

I will now endeavour to explain the method by which we carry out this firing. Here you have in diagram a section through an experimental boiler on which we have operated in Leeds. The boiler is tubular—of cylindrical section. It contains ten tubes, each 3 feet in length and 3 inches internal diameter. These tubes are set at about a distance of 1 inch apart. The length of the boiler is therefore 3 feet between the front and the end plates. The tubes are packed throughout their length with suitable refractory material, composed of Glenboig fire-brick, which is broken up, sieved, and meshed into pieces of suitable size. You must therefore consider the tubes are packed with this material from end to end. At the front end of the tube, we introduce a fire-clay nozzle. This is a cylinder of fire-clay, which is so moulded that it has a centre aperture of $\frac{3}{4}$-inch diameter through which the gaseous mixture can be fed. The object of this is twofold. In the first place, it would not do to have combustion taking place near the front plate of the boiler, so we want to protect this end from any excessive heat. This is one purpose served by the fire-clay nozzle. In the second place, we must introduce combustible mixture at the rate of back-firing; and in order to do this we must have an aperture not more than 1-inch diameter. Therefore it serves the purpose of preventing a too narrow aperture and also protecting the front plate of the boiler from any external heat. In front of the tube we have the feeding chamber, which is represented diagrammatically. We bring into this chamber gas and air mixed in suitable proportions; the proportion of air being just sufficient to burn the gas. The quantity we bring into the feeding chamber is something like 100 cubic feet per hour of coal gas for every tube of the boiler—that is to say, for a 10-tube boiler, we bring in 1000 cubic feet of gas. There is mixed with this gas, homogeneously, the proper proportion of air—the air supplied being so regulated that the cold product shall be found to contain from 1 to 2 per cent. of oxygen; but we can work to as low as $\frac{1}{2}$ per cent. The oxygen passes in, and is caused to burn in the bed of granular material in the tubes. So rapid is the combustion, that at a distance of from 4 to 6 inches from the fore end, we can discover no more combustible material in the tube. The remainder of the packing serves to baffle the burnt gases as they pass through the tube; and we find that in this way enormous heat transference takes place. As a matter of fact, after the gases have passed down 3 feet of the boiler-tube, the temperature of the products is reduced to within 70° C. of the temperature of the water in the boiler. In order to force the mixture through the boiler, we must have it under pressure. These figures are from an actual trial of this boiler. The pressure here is 17·3 inches water-gauge. The mixture is passed through the boiler-tubes, and it leaves the boiler at a temperature of about 60° to 70° above that in the boiler. In this particular case, the water was boiling at a pressure of 120 lbs. per square inch above the atmospheric pressure—that is to say, it was boiling at 170° C. The temperature of the products leaving the boiler was 230° C. But there is still heat in the products which may be extracted; and so, in working this particular boiler, we passed these hot products through a series of tubes, in number corresponding to the tubes of the boiler, each 1 foot long, the same diameter, and packed in the same way. The heat transference goes on; and we feed the chamber with cold water, which enters the bottom, passes up round the tubes, and is then taken away to the pumps, which pump it into the boiler. In this way we are able to reduce the temperature of the outgoing gases from the system to the boiling-point of water itself—95° C.

I have described this boiler as it is erected for being fed with gases under pressure. But since all we require is a difference in pressure from the back end to the front end of the boiler, we can draw in our mixture by suction; and in the first patent taken out we have brought out a method by means of which the whole of the mixture is drawn through the system by hand pressure. We find that this is more economical. I want now rather to confine myself to the pressure. You get intensive surface combustion. In the first 6 inches the heat is communicated by radiant energy. We use, therefore, the full conducting capacity of the boiler-tubes, and we transfer the maximum amount of heat that is possible, having regard to the conducting capacity of the tubes. How great is the heat transferred in such a boiler, you will realize if I give you one or two figures from actual tests. In the first place, in such a boiler, with tubes

3 feet in length, where we feed the gas at the rate of 100 cubic feet per tube per hour, the total evaporation over the whole of the boiler corresponds to the evaporation of 21 lbs. of water from 212° Fahr. per square foot of heating surface. This is about double that of an express locomotive boiler. In an ordinary Lancashire boiler, the figure is about 7; here it is 21; and in an express locomotive boiler it is perhaps 10. In the next place, of this very large evaporation two-thirds occurs over the first foot of the tube, one-fourth over the next foot, and only 10 per cent. over the third foot. So that we get very large evaporation at this end compared with the other end of the boiler. So great is the difference, that there is set up in the boiler a vigorous natural circulation of the water—so great, indeed, that the very circulation of the water itself helps the heat transmission; and it is no doubt a factor of some importance in effecting this rapid heat transmission.

Here are some photographs of the actual boiler of which I have been speaking.* One shows the front end of the boiler, which is about 2 ft. 6 in. in diameter. This seems rather a crude arrangement of pipes; but as it was set up for experimental purposes, we did not necessarily want any burying of the pipes or any particular form of arrangement. The next slide gives a view of the back end of the boiler, showing where the products pass out of the tubes. The water comes in at the bottom of the tank, raises the temperature, then passes the feed-water pump, and from the pump it is passed to the boiler. I will now refer to a diagram which shows the results. The pressure of the gaseous mixture entering the boiler-tube was 17·3 inches water-gauge. The pressure of the products entering the tubes of the feed-water heater was 2 inches water-gauge. The test was carried out with a pressure in the boiler of 100 lbs. per square inch above that of the atmosphere. The temperature of the boiling water was therefore about 168° C. The temperature of the gas leaving the boiler-tubes was 230° C., and that of the feed-water 95° C.; the temperature of the water entering the feed heater was 5·5° C., and when leaving it it was 58° C. The results of this boiler trial have been repeated times without number; and we are prepared to show the boiler in operation to anyone who may visit our experimental station. We are able to get steam at 120 lbs. per square inch within 20 minutes of firing-up the boiler; and we are able to show to any visitor the fact that when the boiler is steaming at the full rate the products leaving the system are at a temperature below 100°.

Now let me mention one or two considerations with regard to the economy of gas as applied to steam-raising in this way. Gas, of course, for steam-raising must in many cases compete with coal direct. There are cases, such as I have mentioned, where we have surplus gases which must be used either for steam-raising or for power-generation in an internal combustion engine. I refer to instances where we have available either blast-furnace gas or coal gas. We have shown that our process can be used with any of these gases. Therefore our method is available for steam-raising with all forms of gas which are now used commercially; and in regard to surplus gases, such as blast-furnace gases or coke-oven gases, which are now very largely applied to steam-raising purposes, we are able to show an efficiency of from 70 to over 90 per cent.—that is to say, we are able to raise 30 per cent. more steam than was formerly done.

Now comes the point, Is it more economical to fire a boiler by any form of gas rather than to fire it by coal? I have carefully considered this question; and it can be shown that there is one form of gas which can be applied by this method to boiler-firing so as to give an actually lower figure for the heat supplied to the boiler than if the boiler is fired by coal. I have made a calculation of the cost of supplying 1,000,000 B.Th.U. in a boiler in the form first of all of coal of 13,500 B.Th.U. per pound and at 10s. a ton. I have compared this cost with the cost of supplying the same amount of heat in the form of ammonia recovery producer gas, which is the cheapest form of gas. Here I must assume some figures. If we take it that we are dealing with the same coal at the same cost, either fed to the boiler or charged into the producer, then we find that, taking into account the profit which is earned upon the ammonium sulphate produced in the ammonia recovery system, which is something like 3s. 6d. a ton, the cost of supplying 1,000,000 B.Th.U. to a boiler will be, in the case of coal at 10s., 3·96; and in the case of ammonia recovery producer gas generated from coal at the same sum, it will be 3·85 per 1,000,000 B.Th.U. That is to say, with ammonia recovery producer gas the actual cost of fuel would be slightly lower with gas than with raw coal. But if we can obtain an efficiency of 90 per cent., instead of 75 per cent., then we must take into consideration, not the cost of supplying 1,000,000 B.Th.U. to the boiler, but the cost of supplying it to the water. If we take this into consideration, with a coal-fired boiler, the cost will be 5·28d., and in the case of ammonia recovery gas it will be 4·28d.—that is to say, a difference of 23 per cent. in the cost alone. Of course, this saving does not represent by any means the whole economy of gas-firing boilers. You save the labour of stoking; and a great many other costs are reduced when you fire a boiler by gas instead of by raw fuel.

This brings us to the important question of whether, and how, boilers of this type may be applied to the combustion of gas on a large scale. We have now under construction a boiler of 100 tubes, 4 feet in length, each tube 3 inches in diameter. It is being constructed for the utilization of coke-oven gas; and it will be in operation upon blast-furnace gas in a very few weeks. We are awaiting with considerable interest the result of the first trial of this boiler. I have no doubt at all in my own mind that we shall attain quite as high, if not slightly higher, efficiency as in this case, because we are going to work with a bigger unit, in which event our radiation loss will be less.

After the close of the lecture, I propose to show you the firing-up of this three-tube boiler. It was one of the first experimental boilers that was tried; and it was constructed for us by our good friends Messrs. Clayton, Sons, and Co., of Leeds. We will fire it up, and I will prophesy that within 20 minutes we shall have steam at 100 lbs. pressure; and the temperature of the products leaving the boiler will not exceed 70° of the water boiling in the boiler.

I am afraid my remarks have been extremely disjointed; but I hope I have succeeded in convincing you that there is something in surface combustion.

The PRESIDENT said the members who took an interest in gaseous firing would have been greatly interested in the lecture.

Mr. H. L. DOHERTY (New York) remarked that Professor Bone's lecture had been listened to with great appreciation and interest; and he had pleasure in moving a vote of thanks to him—hoping that he would feel that it was an expression of appreciation not only from the United Kingdom, but also from the United States.

Mr. THOS. GLOVER (Norwich) seconded. Gas engineers, he said, were particularly interested in the application of gas, as well as in the developments of cheaper manufacture, because the two things had to keep pace with each other. It was no use to offer to the public cheap gas, unless they had the means of using it. What they had heard that evening would help them in the industrial use of gas for many purposes. A great deal of preparatory work had to be undertaken to make it possible to give the lecture; and their thanks were due to the President for what he had done in this respect.

The vote of thanks having been unanimously carried,

Professor BONE, in returning thanks, said he was under a great obligation to the President for the trouble he had taken in arranging the demonstration table and the supplies of gas and air. He had also to thank his assistants who had so ably supported him. As an instance of the economy of the new process, he might mention that Mr. James Wilson, who had had to carry out brazing work at Alnwick, informed him that, whereas under the old method they used for a given amount of work 3 cubic feet of gas, they could now do the same quantity of work with 1¼ cubic feet.

* These were given in the "JOURNAL" for April 11, p. 100.

The Compressors Used at Dr. Bone's Lecture.

For the purpose of the demonstrations accompanying Professor Bone's lecture on "Surface Combustion" at the meeting of the Institution of Gas Engineers last week, air and gas were supplied to the hall at a pressure of 54 inches of water by two electrically driven compressors of the rotary type manufactured by Messrs. James Milne and Son, Limited, of Edinburgh. The capacity of the air-compressor was 5000 cubic feet; and that of the gas-compressor 1000 cubic feet, per hour. No receiver was used between the compressors and the lecture-table; and the oscillation or fluctuation in pressure did not exceed 2-10ths on the water gauge. The compressors are so constructed that a bye-pass valve and relief valve are built upon them—thus doing away with bye-pass connections.

GAS STOCK AND SHARE MARKET.

(For Stock and Share List, see p. 943.)

THE Stock Exchange had a better time last week than the week before—at least, to the extent that the influences were not uniformly malign, and that the close was better than the opening. But the start had been very discouraging—caused chiefly by banking alarms, strike threats, and possibilities in Morocco and in the near East. The apprehension aroused was perhaps more than was justifiable, but panic is contagious and unreasoning. Some of the best markets were the most affected at first, and showed the most recovery afterwards. Monday was the bad day—gloomy and depressed. Consols fell ½, the gilt-edged class generally were lower, and Rails went down in sympathy. Americans were the only fair spot. On Tuesday, calmer views prevailed, and there was some recovery. Consols jumped up $\frac{3}{16}$; but other of the choicer lines were weak. Rails see-sawed up and down; the close being about a drawn battle. The position was fairly maintained on Wednesday. Government issues were steadier, and Consols gained another $\frac{3}{16}$; but Railways were perturbed by the shipping unrest, and prices were put down. Thursday's tone showed improvement; the settlement of the account being reassuring. Gilt-edged lines were firm. Rails, after hesitation, were in good demand and advanced; and the Foreign Market was steady. Friday was quite fair. Rails were stronger, and scored some advances in spite of Friday realizations. Saturday was very quiet, and the tone was fairly maintained. Consols continued steady, and Rails were pretty cheerful. In the Money Market, there was a good demand and an adequate supply. Discount stiffened, but closed easier. Business in the Gas Market was only moderate; but the tendency was very firm, though there were but few changes in quotation beyond those arising from *ex div.* adjustments. In Gaslight and Coke issues, the ordinary was fairly active and stronger. Transactions were between 105½ special and 106¾—a rise of ½. In the secured issues, the maximum realized 87, the preference 103¼ and 103½, and the debenture 80¾ and 81¼ *cum div.* and 78⅞ *ex div.* South Metropolitan was quite inactive, and marked from 119 to 119¾. The debenture made 81¾. In Commercials, there was only one deal in the 3½ per cent. at 109½. Among the Suburban and Provincial group, Alliance and Dublin was done at 84½, Bournemouth "B" at from 16½ free to 16¾ (a rise of ⅛), ditto preference at 14½, Brentford old at 258 and 261, ditto new at 204 and 205½, and Tottenham "B" at 118. In the Continental companies, Imperial changed hands at from 186 to 187, ditto debenture at 92 and 92½, Union at 93 and 94½ (a fall of ½), ditto preference at 135½, and European at 19¼ and 19½. Among the undertakings of the remoter world, Ottoman was dealt in at 7 1/16 and 7⅛, Primitiva at from 7 5/16 to 7½, ditto preference at from 5⅜ to 5 9/16, ditto debenture at 98½ and 98⅝, San Paulo at 20⅛, and ditto preference at 12 1/16 and 12¼.

ELECTRICITY SUPPLY MEMORANDA.

Notes and Platitude—The Statements and the Facts—Ambiguity—Wanted Positive Explanation—Renwick's Enthusiasm and the "Review's" Ambitions—Outside Shop Lighting—Institution of Electrical Engineers.

WITHOUT appearing to be captious, meddlesome, or wanting in respect, there are one or two suggestions we should like to make to Mr. L. Crouch, who is honouring the pages of the "Electrical Review" with some "Notes on Electric Street Lighting." There is nothing we like better than that a spade should be called a spade; and therefore we like "notes" to be called notes. The first of the articles is the only one so far perused; and it is composed—there can be no cavilling over the fact—of notes, unassuming and frightfully attenuated. We should like to see them fattened up a bit. It is to be hoped that Mr. Crouch [this is being written before the pressure of Institution week starts] will in his future articles get away from the elementary, that he will avoid the platitudes of electrical writers who have trodden before him the paths of street lighting, that he will not dogmatize, and that he will favour his readers with some proof of certain assertive remarks that he has already made. In notes of the kind, there should be sequence of thought, statement, and explanation, having in view instructive value and possibly other things.

A few points may be suggested upon which we should like to have a little explanation of assertion, as it is in these days very difficult to accept the *ipse dixit* of some writers. Far better is it to have in black and white the proof of the genuineness of the foundation upon which they rely. Mr. Crouch tells us that "in many instances electric street lighting can show undoubted economic superiority over the most formidable of its rivals, which is usually the high-pressure incandescent gas system. In other cases, the economic superiority is less marked, or possibly altogether absent. These economic relationships are invariably so complex as to need full individual examination in every case." But notwithstanding those "invariably complex relationships," and an admission that "generalization in this matter is very difficult," Mr. Crouch shows an extraordinarily well-developed capacity for generalization, and he revels in it to the full. Thus it comes about that he says (and we want further information in regard to it) that, "given tolerably average conditions and reasonably cheap electrical energy and gas supply, flame arcs can more than hold their own, even against the best high-pressure incandescent gas system; that ordinary or enclosed arcs can displace low-pressure incandescent gas; and that incandescent metallic filament lamps can displace low-pressure incandescent gas-lamps and small arc lamps." Now if we were not of an inquiring mind, there might be a disposition to receive with simple faith the statements of the postulatory Crouch. But we should like him to tell us how it was that for the general lighting of the grounds of the Festival of Empire Exhibition and half of the Crystal Palace itself, high-pressure gas-lamps beat the flame arc lamps in open competition; and that the power house at the exhibition has been furnished with machinery by the South Suburban Gas Company, and the machinery supplied with gas by them, for generating electrical energy for both power and lighting, in competition with the local electricity suppliers. These are not idle statements, but actual facts. Again, we cannot understand how it is, if Mr. Crouch is right, that parade high-pressure gas lighting has been playing such havoc among outside shop lighting by electricity—so much so that Marylebone, St. Pancras, and other places have been bestirring themselves to see what can be done to stem the change-over. And they can so far find no way out of it, but to further trim prices already worn-down to the very bone. There is difficulty in reconciling these facts with Mr. Crouch's bare words; so perhaps he will explain.

Almost forgotten instances are the big street lighting contracts secured not only in Westminster but elsewhere by the London gas companies—through the economies and efficiencies realized by the inverted gas-burners. Reminder of these is brought about by Mr. Crouch's reference to the best practical evidence of the economic possibilities of electric street lighting being given by the continually recurrent contracts which undertake the complete supply and maintenance of such a system as will give a certain minimum street illumination. We like that term "recurrent contracts." It rolls about in the mouth like a sweet morsel. There is a fascination about it. So much so that there is a desire to know something more about the contracts to which allusion is made, and the names of the boroughs in which they are to be found. They will surely be mostly electricity supply owning boroughs. But associated is other information that there is an earnest desire to obtain. Mr. Crouch's special attention is invited to this statement in his article:

> The recurrence of such tenders and their profitable working prove that they are not mere "business catchers" run at a loss for the sake of encouraging subsequent orders. *Unfortunately, these remarks cannot be applied to many gas-lighting tenders. For instance, the circumstances attending the adoption of gas-lamps in Westminster and other London areas will be familiar to all readers.*

We have a peculiar interest in ascertaining precisely and particularly what Mr. Crouch means by the words italicized by us. Perhaps he will expand on them in an early issue of the "Electrical Review." He hints at something that has been hinted at before. It is hoped Mr. Crouch will have greater boldness than a former writer in another quarter who has shrewdly abstained from an invitation to supply an explanation of a similar oblique statement, and to say exactly what he means by this little piece of ambiguous insinuation. By doing so, he may have an opportunity of showing the electrical industry that he is willing to serve it, even to the extent of martyring himself. Now let us have the information categorically and fully.

As mentioned in our editorial columns last week, the annual conference of the Electricity Supply Committee has been held. On the occasion, the Chairman of the Committee (Mr. H. B. Renwick) was overflowing with enthusiasm—so we gather from the "Electrical Review." The Committee have now extended the scope of their operations to the whole of Great Britain. It is attributed to the ebullient Mr. Renwick that he thinks (this may be a libel on his commonsense, but we are not the authors of the statement) the universal use of electricity in the house is only a question of making the facts known to the public. The "Review," with its mind well in equilibrium while making the comment, cannot agree with him, though naturally certainly at one with him as to the laudable object in view. The Committee have been at work for some time making known to the public a few facts and many other things; and their energy and their statements—well, if they had all had truth at their base, ought already to have reduced the gas industry to a mere skeleton. It has been a remarkable campaign in many ways. But the "Review" is not satisfied with it. The balance of its mind quavers, and commonsense is temporarily disturbed. What it would like is, instead of a mere Publicity or Advertising Committee, a complete business-getting organization for all London. That is a matter for every individual undertaking. No one business-getting organization can "business get" for the whole of the electricity undertakings in London. It is better not to let ambition fly beyond discretion, or there will be a wreck of the organized aid that the electricity industry has at the present time, though that aid is not consistently entitled to a stand on the pedestal labelled "Truth." However there is something to be said for the "Review." It formed the opinion to which we have referred at the beginning of the electrical publicity campaign, the opinion has been embedded in its brain ever since, and it has evidently taken up its permanent residence there.

Our excellent contemporary comes out in subsequent remarks with two suggestions neither of which is new. It points out that publicity need not be confined to paper and printer's ink. The

cinematograph theatre, it says, offers considerable opportunities for instructing a large section of the population which cannot be reached in any other way. Perhaps our contemporary has seen the "turn" in South London Electric Theatre programmes in which a home, a gas company's show-room, and a gas-cooker in the home, play a prominent part. The wise "Review" also suggests to the Committee that the vicinity of gas companies' excellent show-rooms make suitable situations for conspicuous actual demonstrations in electrical show-rooms. The idea is stale; and where there has been such neighbourly installation, it has served the useful purposes of better educating the public in the greater value offered by gas for domestic uses, and of propagating ridicule on the results of the efforts of the electricians to produce domestic appliances suitable for the household. The wisest thing our contemporary has to say is that the gas companies' domestic business is well established. Mark this—not "seems to be," but "is." The Publicity Committee—notwithstanding the vapid prating as to the universal use of electricity following the circulation of "facts"—are aware that all the facts are not on the side of electricity, and that the well-established gas business has the gas industry to protect and develop it. It is not for the electricity industry to have all its own way; and those in the industry who are prudent have long since accepted this, and have comported themselves accordingly.

St. Pancras is evidently feeling the pressure of gas competition for outside shop lighting; for the Electricity Committee have been very anxiously considering the subject of reducing their charges. They claim a revenue of £5000 a year from private outside lighting, and the users are in a position now to threaten to economize if there is not some consideration paid to them in the matter of price. Trembling for the safety of the £5000 per annum, the Committee have looked into their present charges, and have sought information from other places. Hitherto in St. Pancras energy for this class of lighting has been charged for under the rates in operation for the general electric lighting of consumers' premises. These are as follows: (1) Flat-rate of 4d. per unit; (2) maximum demand indicator system of 6d. per unit for the first hour and 1½d. per unit after; (3) 6d. per unit between the hours of 4.30 p.m. and 8.30 p.m., and 1d. per unit after, and payment of cost of meter, &c., for registering supply. From the information obtained by the Committee elsewhere, it appears that lower charges than the foregoing are made for electric lighting outside business premises in other districts. Battersea charges 2½d. per unit; Beckenham, 3d. per unit, or at an inclusive charge per hour; Bermondsey, 2½d. per unit, conditional on light being used inside also; Finchley, £5 15s. 3d. per 383 hours per annum per 5-ampere circuit at 250 volts; Heston and Isleworth, 3d. per unit; Ilford, enclosed arc lamps, 600-watt, £3 per 500 hours, inclusive of carbons and trimming; Southwark, 3d. per unit. To meet the demands of the case, the Committee have decided that the flat-rate charge for energy supplied for outside frontage lighting of business premises shall be at a special rate of 3d. per unit, from and after the reading of the meter indices at the close of the current quarter, and that rentals be charged for the separate meters required to register the supply. We wonder whether this will be sufficient to stop the inroads of gas-lamps.

It is not often that we notice the annual report of the Institution of Electrical Engineers. But there are a few points about it in which the members of the Institution of Gas Engineers will be interested. Of course, the Institution of Electrical Engineers comprise members from all branches—central station electricity supply, electric tramways and railways, electric machinery of all kinds, telegraphs, telephones, &c. Therefore, it is not surprising that the membership grows by as many as 502 additions in a year—the number mentioned in the present report. Reference is made to the new Institution building on the Embankment. The Council believe that the influence of the Institution on the interests of the electrical industry will be greatly extended by the practice of gathering together there various kindred institutions and societies. There is no doubt about the value of a central home in aiding the status, prestige, and work of a central organization of the kind. Reference is made to the new wiring rules to which some allusion appeared recently in the "Memoranda;" and it is stated that they have been adopted by 49 Fire Offices, and are accepted as standard practice, and their use recommended, by 232 supply authorities. Mention is also made of the street-lighting specification that the Institution is drafting in collaboration with the Institution of Gas Engineers, the Institution of Municipal and County Engineers, and the Illuminating Engineering Society. The Council, it appears, have arranged for examinations for the admission of associate members of the Institution. Lectures and informal meetings are being arranged for. The Institution of Electrical Engineers are not asleep; and yet there are some who complain, and wish there was more activity.

Accidents in Factories and Workshops.—The annual report of the Chief Inspector of Factories and Workshops (Dr. Arthur Whitelegge) has lately been issued. It shows that the number of accidents which occurred in the year ended the 31st of December last was 127,550, compared with 117,500, 122,154, and 124,325 in the three preceding years. The total for 1910 is made up as follows: Fatal accidents, 1080; other accidents reported to certifying surgeons, 42,714; accidents reported to inspectors only, 85,756. Some extracts from the report will be given in a subsequent issue.

CONTAMINATION OF GAS IN GASHOLDERS.

It has frequently been matter of observation that purified gas sent into some particular holder has been found on its exit from it to be contaminated from some more or less obscure source. Entering free from sulphuretted hydrogen, it has on issuing been discovered to contain so much of his impurity; and the question has arisen whence comes this spontaneous fouling, as it were, of the gas.

This question in the case of a gasholder at the Melun Gas-Works, France, was brought to the notice of last year's congress of the Société Technique du Gaz by M. Sellié in the course of discussion.* The matter then being left in an uncertain state, and no definite explanation of the phenomenon having been brought forward, M. Louis Chevalet contributed a short paper on the subject at this year's meeting of the Society, and advanced a theory to explain the matter.

Gas, he says, quite free from sulphuretted hydrogen at the inlet to the gasholder may, at the outlet, soil the acetate of lead paper—that is, of course, without letting any unpurified gas go into the holder. He is convinced of the possibility of the production of sulphuretted hydrogen by biological means in a gasholder tank, whenever the water in it contains an appreciable amount of sulphate of lime. The investigations of M. Planchud and of MM. Etard and Olivier show that living bodies are capable of reducing into sulphuretted hydrogen the sulphate of lime contained in water. So frequently does this occur in Nature, that M. Planchud attributes the production of the greater part of the natural sulphur waters to this one cause.

The living bodies capable of producing this phenomenon are the lower algæ, which approach very nearly to microbes. They have the general name of "thiogènes," and belong to the following species: Oscillaria, Ulothrix, and Beggiatoa, the last named of which are in nearly all the Enghien sulphur waters. But this species of algæ is also frequently found in pools and ponds. The experiments of MM. Etard and Olivier, in planting these algæ in vessels containing pure distilled water with sulphate of lime added, clearly prove the decomposition of the sulphates by these microscopic organisms, and the production of sulphuretted hydrogen. These scientists insist on the fact that the production of sulphur takes place biologically and not chemically. M. Planchud's conclusions are also definite. He says the mineral waters owe their formation to the reduction of various sulphates under the influence of living organisms; the sulphur being the result of fermentation. He has been able even to make artificial sulphur water by imitating the process of Nature.

This being established, it is easy to explain the cause of the contamination of the gas in the Melun gasholder, and its disappearance. The gasholder tank, because of the Seine floods, contained an altogether abnormal proportion of sulphate of lime—say, 0·634 gramme per litre. It was enough, then, for some of above-named algæ to get into this water for the sulpho-bacteria to develop, and for sulphuretted hydrogen to be produced. The Oscillaria species exist in the pools bordering on the Seine. They would pass into the Melun Gas-Works with the general flood of January, 1910, and some of them would be left in the gasholder tank. They would find themselves in water richer in sulphate of lime than that to which they were accustomed, and would rapidly increase and give off sulphuretted hydrogen.

The disappearance of this product is also explained by this theory. These algæ cannot live in presence of traces of carbolic acid; and various anæsthetics, as M. Planchud has shown, arrest their development. The water in a gasholder tank gradually shows traces of carbolic acid, and the sulphuretted carbon which is in the gas would act as an anæsthetic. This explains why the inconveniences pointed out by M. Sellié stopped at the same time that the continuous flow of water into the tank ceased; for there was then a concentration of substances preventing the growth of the sulpho-bacteria.

In cases of contamination by sulphurous bacteria, it is quite useless to add sulphate of iron, which, on the contrary, would provide a further source of sulphuretted hydrogen. The remedy is to be found in the gas-works themselves. It will be sufficient to wash the tar, by making it bubble through ordinary water, and to send this water into the gasholder tank. The water will be charged with a small quantity of carbolic acid, which is poison to the algæ, which will die, and no more sulphuretted hydrogen will be given off.

The contamination of gasholders is a real malady caused by infinitely small organisms very like those which bring about the diseases of men and animals. Moreover, in actual technical language, analogous expressions are used; for the boundaries between the mineral kingdom and the kingdom of living bodies are not of so absolute a character as was formerly thought. Thus physicists speak of the "fatigue" of metals; chemists of the "contagious diseases" of metals. The gas industry will have to reckon on complaints caused by living bodies; but alongside of these pernicious microbes are many others. Bacteria have played a very important part in the formation of coal by the decomposition of vegetable cells. Very rich gas coals, like boghead, are entirely formed by an accumulation of soft water algæ and bacteria. The natural oxide of iron used in purification, which

* See "Journal," Vol. CX., p. 939.

is found in some countries in very thick deposits, and is known under the name of bog ore, is due wholly to the action of ferruginous bacteria, which are nearly related to the sulphurous bacteria which have been referred to.

PERSONAL.

The Manchester Corporation Gas Committee at their meeting last Friday appointed Mr. WILLIAM KAY as Deputy-Chairman, in succession to the late Alderman Briggs. Mr. Kay has now resigned his position as Deputy-Chairman of the Electricity Committee of the Corporation, but he retains his membership of the Committee.

On leaving the service of the Ipswich Gas Company to take an important appointment with the Shanghai Gas Company, Mr. WILLIAM HARVEY was presented, on Monday evening last week, with a fitted dressing-case and another gift from the staff, also a travelling rug from the town office employees, accompanied with good wishes for his success in his new surroundings.

At last Friday's meeting of the Bolton Corporation Gas Committee, a letter was read from Mr. ARTHUR E. SAVILLE, tendering his resignation as Superintendent of the Gas Street works, and asking to be relieved of his duties as early as possible, in view of his appointment as Engineer, Manager, and Secretary of the Farnham Gas and Electricity Company. The resignation was accepted.

OBITUARY.

We regret to record the death last Wednesday afternoon, at his residence at Belvedere, Kent, of Mr. JAMES JOHN FREDERICK STEVENS (more generally known as Mr. Frederick James Stevens), the Chairman of the Mitcham and Wimbledon and the West Kent Gas Companies. His decease, at the age of 71, was the sequel to an attack of paralysis early in the year, up to which time he had been actively engaged in his business. In early life, Mr. Stevens studied for the medical profession; but he preferred engineering, and became associated with the construction of several railways, and invented various appliances for signalling purposes. Turning his attention to the development of the gas industry, he introduced from his works in Southwark a number of patented devices; and finally devoted himself entirely to the manufacture and supply of gas—becoming Engineer and Chairman of the West Kent Gas Company. But he never forsook his attachment to medicine; pursuing it as a fascinating hobby, and combining with it a study of botany. Painting and music also attracted him. A devoted member of the Roman Catholic Church, his legal and commercial knowledge was constantly made use of by the clergy; and his linguistic accomplishments, derived from extended travels on the Continent, were of great assistance in negotiations with ecclesiastical dignitaries from abroad. Mr. Stevens was highly respected in the district with which he had been associated; and the news of his death was received with the deepest regret—flags at the gas-works and other buildings being put at half-mast as soon as the mournful intelligence was received. The interment took place yesterday afternoon, at the Monastery, Bexley Road, Erith.

Profits in Aid of Rates at Rochdale.

A revised edition of the Rochdale Borough Treasurer's abstract of the Corporation accounts contains a series of statistical appendices not included in the advance copies prepared for the May meeting of the Council. One of the tables given shows that in the last fifteen years nearly £180,000 has been contributed from gas profits in aid of rates. The largest sum thus handed over in any one year was £19,598, for 1905-6. The year before that the amount was £18,228; but it included £5228 from the gas reserve fund, and of the £14,355 given for 1902-3, £2500 came from the fund. The following are the amounts allocated in the period under notice. Prior to 1904-5, the lighting of the street-lamps was placed to the gas account. Since then the amount per annum has increased from £5228 to £7730 for the current year. The Electricity Department has contributed in aid of the rates £22,000 since 1905-6. Compared with seventeen years ago, the water-works deficiency is now between £4000 and £5000 less. The deficit has, however, fluctuated. Fourteen years ago, it was £3900; eleven years ago, it was upwards of £6000; while three years back, it was only about £1300. The total expenditure of the borough has increased in fourteen years by £58,167—that is to say, from £79,972 to £138,139. Thanks to the gas and electricity profits, all the expenditure has not had to be raised from rates. The amount of the levy on the ratepayers has grown from £70,729 in 1898-9 to £120,986 this year—an increase of more than £50,000, and almost twice as much as it was seventeen years ago. This year the Corporation rates total 6s. 8d. in the pound; and, in addition, there is a poor-rate of 1s. 3d.

THE LABOUR QUESTION IN MILAN.

The Truth about the Gas-Workers.

THERE appeared in last week's "JOURNAL" (p. 737) some reference to the relations existing between the Union des Gaz Company and their employees in Milan. The particulars given—which, as then mentioned, were culled from Italian newspapers—included a statement that a resolution was unanimously passed at a meeting of the general body of gas-workers "attributing the unrest to an alleged attempted new 'organico' sought to be imposed on the men by the Union des Gaz Company." Such unrest as exists, we are authoritatively informed, is not due to the cause named—for the sufficient reason that the Company have not attempted to impose a new "organico" on the men. On the contrary, it might be more truly said that the trouble is caused by the Gas Union leaders, who fear that they may find their occupation gone.

From the facts of the case as they have been placed before us, it appears that during the last two or three months a section of the men have been more or less agitating for the repeal of the present "organico," which was given after the strike failed in 1909. They want to return to the "organico" of 1907—which really means that the men desire to revert to the system of being masters of the works. Thus the papers are incorrect in asserting that this unrest is due to an attempt by the Company to foist a new "organico" upon the men—the Company merely wish to maintain the existing one. Seeing, however, that some of the staff were desirous of a modification being made in the clause relating to arbitration, the Manager (Sig. Grüss) indicated that he was prepared to meet them by slightly altering it; and, further than this, to remove any excuse the men might think they had for striking, he proposed a new scale which would place the men of over ten years' service on a better footing as regarded their rate of pay. The agitation is evidently being fostered by the Gas Union leaders, and not by the men as a body, because the latter are satisfied and working well.

Last Saturday week the time arrived for discharging the men who are not required during the slack season; and as the new coke-handling machinery is also coming into action, it was found necessary to get rid altogether of some 120 men. Fearing, from knowledge which was in his possession, that this might lead to some trouble, the Manager thought it would be best to prepare himself for any emergencies, so as to ensure that the town might not be left in darkness. This was accordingly done, by providing a reserve of men; but the employees did not strike on the Saturday, as had been thought they might do. When, however, on the following Tuesday morning, they imagined that the men who had been specially brought over had been sent back again, they did strike. Luckily for the Company, they were mistaken in their assumption; for the reserve men had not been removed. On the contrary, they were promptly brought into the works; and by this means the supply of gas has been maintained.

It is gratifying to be able to record that everything is quiet at all the other towns with which the Company are connected.

THE LATE ROBERT B. FENWICK.

A Memorial Fountain.

A PLEASING function was witnessed last Wednesday afternoon by a large number of people, who assembled at Wandle Park, Wimbledon, for the unveiling of the Ashby and Fenwick Memorial Fountain. This is a handsome memorial (executed in marble, surmounted by a graceful figure in bronze), which has been erected by a Committee, to whom Mr. R. S. Gardiner has acted as Chairman, while Mr. C. H. Cooper, M.Inst.C.E. (the Wimbledon Borough Surveyor), has fulfilled the duties of Hon. Secretary. The spot chosen is an eminently suitable one for the purpose, inasmuch as the fountain stands in what were formerly the grounds of Wandle House, from the windows of which it can be seen; and it was in this house (which, with the grounds, has now been acquired by the Wimbledon Borough Council) that Mr. Fenwick lived for a long period. Mr. Fenwick (who, with Mr. Ashby, did much good work in Wimbledon) possessed a great many friends in the gas industry, especially among provincial engineers; but for the benefit of those who did not enjoy the pleasure of his acquaintance, it may be remarked that he was a Director of the Mitcham and Wimbledon Gas Company and of the old East London Water Company, and that for a good number of years he occupied the position of General Manager of the Pelton Collieries.

The proceedings on Wednesday opened with some songs by girls from the Hubert Road and Effra Road Schools, who were conducted by the composer, Mr. Theodore Holland; and then Mr. Gardiner made a few opening remarks, in the course of which he pointed out that they were gathered together to pay a tribute of respect and regard to the memory of two good men—Harry Pollard Ashby, one of the oldest members of the Wimbledon Local Board, and Robert Bloomfield Fenwick, an Alderman of the Surrey County Council and a Justice of the Peace—who, by their strenuous, unselfish, and unstinted efforts to brighten the lives of others, earned the regard and love of their fellow men. The Committee who were about to hand over this memorial had, he said, been not only assisted, but had had the whole of their work discharged by one man; and this one man, who originated the

memorial, and who fought against many difficulties and overcame many delays, was their townsman Mr. Cooper. It was not within his province to dilate upon the virtues of Mr. Fenwick, because the devoted manner in which he served the interests of the undertaking committed to his charge would be referred to by Lord Dunsany, his civic labours would be dealt with (in the regrettable absence of Alderman Summerhays, of the Surrey County Council) by Mr. A. J. Penny, a member of the Borough Council and of the County Council, and his great work of charity and piety would be alluded to by the Rev. A. M. Pickering, Rector of Woolwich, and the first Vicar of All Saints. He would like, however, to refer to one characteristic of both men, and that was their wonderful reliability as friends.

Lord Dunsany, who next addressed the gathering, said that Mr. Fenwick worked diligently and well for fifteen years, as General Manager of the Pelton Collieries, on behalf of his (the speaker's) family. When they were all assembled to do Mr. Fenwick honour, it would have been inappropriate if he had not come to give his opinion of the work that gentleman had spent part of his life in doing. He had always heard him spoken of by his family in terms of praise and admiration. The other two gentlemen referred to by Mr. Gardiner also spoke; and the memorial was unveiled by Mrs. Charles Maffett, daughter of Mr. Fenwick—the water being subsequently turned on by Mr. Cuthbert Maffett, a grandson. Prayers were said by the Right Rev. the Bishop of Kingston. On one side the memorial bears the following inscription:

> Robert Bloomfield Fenwick. Born 1835, at Monart Rectory, Co. Wexford. Lived at Wandle Park, 1867-1895. Died at Great Bardfield, Essex, 1897. He was an Alderman of the Surrey County Council, 1889-1895, and a Justice of the Peace. Through his influence and generosity All Saints' Parish was founded and its church erected. He built and endowed the Hubert Road Institute.

The memorial was then handed over to the Wimbledon Corporation by Mr. Gardiner, on behalf of the Committee, and was accepted for the Corporation by the Mayor (Mr. J. Marshall Bathgate). Mr. Gardiner, in doing this, acknowledged the great indebtedness of the Committee to Mr. Fritz Roselieb, the Sculptor, who designed and created the monument, and to Miss Helen Rock who reproduced likenesses of Mr. Ashby and Mr. Fenwick on two medallions at the sides.

A vote of thanks was heartily accorded to the Memorial Committee, on the proposition of Alderman Simpson, seconded by Mr. Richardson Evans; the work of Mr. Gardiner and Mr. Cooper in connection with the matter being specially referred to. Mr. Cooper responded; and then there was an adjournment for tea, which one thousand children of All Saints' Parish had been invited to partake of.

THE "EVENING STAR" MANTLE.

Those persons whose work brings them into contact with incandescent gas lighting are probably aware of the claim advanced for loom-woven mantles—that they are of much greater strength than the ordinary knitted mantle, which is accounted for by the fact that, instead of knitting the ramie thread on a knitting-machine, it is woven on a loom, thus producing an even square pattern, having no sharp angles; the threads being locked where they cross, and so forming a firm and stable whole, eminently suitable for the purpose for which it is intended.

A New Loom-Woven Mantle.

Messrs. Curtis's and Harvey, Limited, have now on the market two types of loom-woven mantles. In the first place, there is their well-known "Ironclad," fitted with the patent metal top, which strengthens the head of the mantle, and ensures its hanging steady. Then there is the new "Evening Star" pattern, which (as will be seen from the accompanying illustration) is designed and woven on a loom in an eccentric fashion, in order, it is pointed out, to secure the greatest strength coupled with the utmost luminosity. The special feature is the tight weaving at both the head and the skirt of the mantle; the importance of the latter being that it secures great strength at the point where the mantle comes in contact with the head of the burner. The makers claim that this is an entirely new departure in gas mantles, which should prove of great use to gas engineers for street lighting and maintenance work. Certainly, the specimen submitted to us proved itself perfectly well able to bear more than a fair share of "knocking about." The "Evening Star" mantle has not been on the market long; but we are informed that many gas engineers who have seen it have expressed themselves as very pleased with it.

MEETING OF JOINT COMMERCIAL SECTIONS.

The Annual Meeting of the Joint Commercial Sections was held in the Technical College, Glasgow, last Wednesday afternoon—Mr. Alex. Wilson in the chair.

The Hon. Secretary (Mr. H. Kendrick, of Stretford) read the minutes of the last meeting; and they were unanimously adopted. He also reported that he had received a letter from the Eastern Section of the Eastern Counties Association, stating that they found themselves unable to continue membership of the Joint Sections.

The following report to the Institution of Gas Engineers was taken as read—Mr. Kendrick saying that he had only one remark to make regarding it, which was that now, after the receipt of the letter from the Eastern Counties Association, seven instead of eight Associations took part in the joint meetings.

Report of the Joint Commercial Sections.

To the Council and Members of the Institution of Gas Engineers.

Gentlemen,—The work undertaken by the sections continues to extend; and we have to chronicle during the past twelve months the advent of three new sections: The Special Purposes Sections of the North of England and South Wales Gas Managers' Associations, and a Commercial Section in North Wales. These make a total of fourteen sections in full work, if the South-Western and Cornish Associations are included. Of these fourteen sections, eight take part in the joint meetings; and strong hopes are entertained that the number will be considerably increased, as it is recognized that co-operation and joint action can render valuable service to the whole industry.

The need for work done by these sections has been generally recognized; and the movement is now definitely established. The recognition of the work done by the sections in the past by the Institution has materially helped to strengthen their position; and anything further that can be done to assist the sections, and extend their usefulness, by increased facilities for holding conferences, will make for the benefit of the movement and the whole gas industry.

The watching, collecting, and distribution of information relating to the coal and residual products markets, has been done thoroughly in most of the sections, and has been of the greatest benefit to the affiliated undertakings, and indirectly to the non-affiliated ones also. Membership of the various sections by these latter would not only assist their neighbours, but would be to their own advantage, and that of the undertakings they serve.

The more important of the general topics discussed at the meetings were:—

Prices of materials.
High-pressure lighting charges.
Gas-heating apparatus sales.
Charges for power and stand-by supplies.
Organization of the fittings staff.
Education of the gas-fitter.

Both the subject-matter and the discussion of some of the topics introduced impromptu have been of great interest and value to the industry generally; and this part of the business is capable of great extension.

The most important matter dealt with by the sections has undoubtedly been that of "Publicity;" and the Committee appointed at the joint meeting held in London, on June 14, 1910, to carry out the scheme then endorsed, prepared to call a conference of representative gas undertakings, to elaborate the scheme before submitting same to the Institution, as directed by the joint conference, or to the industry as a whole, when the Council of the Institution intervened with a proposal to take over the duties themselves in conjunction with the Commercial Sections Committee. The negotiations which ensued resulted in the amalgamation of the two, forming one large "Publicity Committee."

The steps taken by that Committee to further the objects of the movement are well known; and the Joint Sections hope that the support accorded to the scheme will enable the Committee to operate on such a scale as will ensure success. They recognize that it is important that those gas undertakings at present outside the scheme should be urged to join it, as the larger the sum available for this object, the more effectively will the work be done; and the Joint Sections will continue to commend this matter to the earnest consideration and support of all the undertakings coming within the sphere of influence of the Commercial and Special Purposes Sections.

On behalf of the sections,

S. Meunier, *Convener.*
H. Kendrick, *Hon. Sec.*

Gas-Works, Stretford, May 24, 1911.

Mr. Charles Wood (Bradford) moved the adoption of the report.

Mr. Edward Allen (Liverpool) seconded; and the motion was unanimously agreed to.

Sulphate of Ammonia—Committee's Propaganda Work.

Mr. S. Meunier (Stockport), the Convener of the Joint Commercial Sections, said it seemed to him that one of the subjects which would have to be taken up more seriously, and which, in his opinion, ranked only second in importance to the Publicity

question, was how to induce the various undertakings to subscribe to further the interests of sulphate of ammonia manufacture.

Mr. F. H. Pickles (Kildwick) wished it to be made more clear that undertakings, whether they manufactured sulphate or not, should subscribe. They all obtained the same benefit. He might mention that nine or ten large towns already subscribed.

The Chairman remarked that Mr. Meunier had not moved a resolution, but had sought to impress upon the members the necessity for all undertakings, whether sulphate makers or not, subscribing to assist in the propaganda work.

Mr. H. C. Head (Winchester) moved a resolution to the effect that all the Commercial Sections impress upon their members the necessity for the various corporations and companies subscribing to the propaganda work of the Committee.

This was agreed to.

Education and Certification of Gas-Fitters.

The Hon. Secretary stated, with reference to this subject, that the idea was to submit the proposals which had been drawn up to the District Associations before they asked the Institution of Gas Engineers to step in and approach, probably, the City and Guilds of London for their support. He did not intend to read these proposals through; but he had heard one or two criticisms of them, which he thought were, in the main, founded on a misunderstanding. He answered one or two of the criticisms at Doncaster; but he had since had complaint of the same kind again. The criticism appeared to be directed wholly to one paragraph, and was that, if the proposal were carried into effect, it would prevent men practising as gas-fitters who were doing so at the present time. There was no intention in the minds of the Committee who drew up this suggestion that any scheme which would be put forward would be retrospective. It was to apply entirely to the future, and was that, after a day had been fixed, men would not be allowed to practise as gas-fitters, under the authority of gas undertakings, unless they passed a certain standard. In regard to another complaint, they hardly looked upon a man who fixed a meter as a gas-fitter; and it was not intended to deal with this class of men at all. With regard to the question of examination, this, in his opinion, was a matter which would require attention. In his own little experience, he had found that many students of the present day, by lack of attention to ordinary knowledge, had absolutely lost a great proportion of the elementary education which they originally possessed, and were more or less incapable of answering written questions in an intelligent way. It had been suggested that the written examination should not form the main portion of the work of examination.

Mr. J. F. Bell (Derby) felt that the education of gas-fitters was one of the most important questions they had to face. They wanted to retain their lighting, but found the complaints received about bad gas were generally due to defective fittings.

Mr. Tim Duxbury (Oldham) expressed the opinion that they could not carry the proposal that no gas-fitter would be employed unless he had obtained a certificate. They could not compel corporations or gas companies to do this. Their plumbers were not plumbers in the ordinary sense of the term. They were a kind of handy men, who did the work required of them; but they did not go in for plumbing generally.

Mr. Herbert Lees (Hexham) was sure the members of the sections must feel indebted to the Manchester District Institution, and especially to Mr. Kendrick, for the amount of work they had put into this subject. Having had some little experience with students, and with gas-fitters who were not students, he concurred in Mr. Kendrick's view that it would be difficult to get many of these men to undergo examination. The very word "examination" frightened a majority of present-day gas-fitters. They wished to improve the theoretical knowledge of the men, whatever their practical knowledge might be. His view was that any scheme to attract gas-fitters must be carried out in a more local fashion than the scheme which was suggested. It was quite true that some undertakings were too small to conduct classes; but he thought it should not be difficult to make such an arrangement as would enable any undertaking employing half-a-dozen or a dozen gas-fitters to give them instruction. The difficulty would probably arise as to how many people would be willing to undertake the duty of teaching. They had not discussed this yet. His view was they should proceed slowly.

Mr. Head was afraid that the proposal that the practical and oral portions of the examinations should be conducted by examiners appointed by local committees would not do. Unless the gas companies themselves saw that the work was done, it would not be done. He did not see how the proposal that no gas-fitter, after a date to be determined, would be employed by a gas undertaking, or allowed to fix apparatus unless he had obtained a certificate, could be made possible without an Act of Parliament—unless, of course, they were to play the part of a most tyrannous Trade Union.

Mr. Allen did not agree with every point in the recommendations; but he was sure that there was no intention on the part of the Committee to suggest that anything should be compulsory. It was quite in the interests of gas-fitters themselves that this matter should be taken up. Under such a scheme as was proposed, gas-fitters would be trained to do their work properly; and they would be better paid for the work, when they could do it.

Mr. J. Paterson (Cheltenham) stated that last autumn he gave a course of lectures to their gas-fitters; but he could not teach them practically.

Mr. B. F. Browne (London) urged the importance of gas-fitters being trained in meter-shops, as was done in France, Spain, and Italy.

Mr. R. Watson (Doncaster) thought that, before adopting the suggestions which were proposed, the matter should be referred to the Manchester District Institution, who might re-draft the proposals in the light of what had been said at the meeting. He was sure the Institution referred to would welcome the remarks which had been made.

The Hon. Secretary explained that they wanted to get an expression of opinion from those present. If the meeting approved generally of the scheme, the details could be filled in afterwards. The conditions in the South were very different from those existing in the Lancashire districts. What he wanted was to have a scheme drawn up which would ensure, as far as possible, the education of gas-fitters; and if they had the approval of the meeting generally, he thought they would have done as well as the Manchester Institution would desire. It was quite recognized by them that it could not be made a compulsory matter. Their view was that a scheme such as was now proposed would be a benefit, not only to the gas companies, but to the gas-fitters. Part of the criticism they had heard was, he believed, based on a misconception. It was not intended that the scheme should overlap existing arrangements. It might be necessary to divide the present "Gas Supply" course into two—one of fittings and the other of supply. The main difficulty, in his opinion, would not be in arranging the syllabus, but in finding teachers; and this would probably obtain, until they had trained some themselves. Last year he took up some of these classes at Salford, because he desired to see the work through and get practical experience. He was afraid he would have to do the same in the coming winter, simply because the men of the present time had not been trained in the manner in which some of them would like; and it would probably take a year or two before they could see that they had the right men for the work of teaching. He thought that if the members of the profession generally were prepared to sacrifice one evening a week, they could get the matter properly arranged. The Manchester Institution did not see eye to eye with Mr. Lees, that the scheme should be treated as a preliminary course. Mr. Lees' suggestion would, however, receive careful consideration.

Mr. Lees moved that the meeting express their deep appreciation of the services rendered by the Manchester District Institution of Gas Engineers with regard to this question, and that the proposed scheme be referred to the District Associations for their opinions upon it.

Mr. Paterson seconded the motion.

The President said he was sure the Manchester Institution would be better able to deal with the matter when it came before them again, after the discussion they had had. It was an important subject, and it deserved the best attention of all. A great deal of the successful working of gas appliances depended upon the way in which they were fitted. They had been doing something in Glasgow upon the same lines, but had not got very far; and he had been taking mental notes, in order to see how they could go farther than they had hitherto been doing.

The motion was agreed to unanimously.

Arrangements with Gas-Fitters.

Mr. Charles Wood (Bradford) expressed the feeling that this was entirely a matter for local consideration. Any such system as that proposed would be utterly inapplicable to any of the Yorkshire gas undertakings.

Mr. Paterson mentioned that he had a working arrangement, or tried to make a working arrangement, with a local firm of gas-fitters. The firm said they would be quite willing to take up an agency for them, provided they were to be the only agents employed in the town. This would not suit them at all. At length he obtained one gas-fitter, who not only agreed to take up the agency, but also to give up a big electric light business. But he laid down the condition that the Gas Company should not interfere with him in the pushing of his business, and should not do any fitting themselves. He had as yet not been able to succeed in establishing any fitting agencies.

Mr. L. D. Mosley (Seaford) said they had an arrangement with a firm to allow them to have the use of a window for show purposes. But they found it was bad; and they began to show at their own works. Since then they had had a large increase of business. Though the firm gave them very good terms, they treated them very badly.

The Hon. Secretary read a letter he had received from Bournemouth, in which the allowances to ironmongers were given. He said he was afraid the prices quoted as being charged at Bournemouth would not suit in Lancashire. They were about double what they paid.

The President stated that in Glasgow they came to an arrangement with the trade as to the rates to be charged and the materials used. This had worked very well; but, on the whole, they found that they could do the work much better themselves. At the same time they were getting on very well with the traders. As to traders showing goods, this turned out to be a failure; and they had opened a large shop of their own in Sauchiehall Street, where they were doing an immense amount of business.

Mr. S. Meunier proposed a hearty vote of thanks to the President for putting himself to the trouble and inconvenience of taking the chair at the meeting.

This was cordially agreed to; and the proceedings terminated.

GLASGOW MUNICIPAL UNDERTAKINGS.

It was intimated on the programme of the annual meeting of the Institution of Gas Engineers that the gas-works and other municipal undertakings of the Corporation of Glasgow would be open to the inspection of the members; and they were visited (especially the gas-works) by a goodly number. A pamphlet furnishing full particulars, with portraits and illustrations, of the different departments, had been prepared for the visitors; and from it we extract the portions of special interest to our readers. It may be mentioned, however, that the Provan and Tradeston Gas-Works were described in the "JOURNAL" on the occasion of the visit of the German Gas Engineers to Glasgow last October.

HISTORICAL AND STATISTICAL PARTICULARS.

It is nearly a hundred years—viz., in 1817—since an Act of Parliament was obtained and the first gas-works were erected for the supply of Glasgow; the site being on the west side of Kirk Street, near the High Kirk. The first street-lamp was lighted with gas on Sept. 5, 1818. It was not until 1827 that definite returns could be obtained as to the general gas supply, as meters had not been in use. In that year, however, 79¼ million cubic feet of gas were made; and it was sold at 10s. per 1000 cubic feet. [Last year the make was 6978 millions; and the prices were 2s. for lighting, 2s. 7d. for prepayment supplies, and 1s. 8d. for manufacturing purposes.] From 1835 to 1838, ground was purchased and works were erected at Tradeston; and from 1841 to 1843, the land was bought and the works put up at Partick. These works were carried out by the Glasgow Gaslight Company. In 1843, the City and Suburban Gas Company obtained an Act of Parliament, purchased ground, and erected gas-works at Dalmarnock. Both Companies continued to supply gas in competition, within the same area, until 1869, when the Corporation acquired the undertakings. From 1871 to 1873, they bought ground and put up gas-works at Dawsholm. In 1891 and 1892, the works of the Partick, Hillhead, and Maryhill Gas Company and the Old Kilpatrick Gas Company, as well as those at Milngavie, were acquired; and from 1900 to 1904 the Provan works were commenced and opened. The daily manufacturing capacities, in millions of cubic feet, of the five works belonging to the Corporation are: Provan, 12; Dawsholm, 18; Temple, 1; Tradeston, 10; Dalmarnock, 7. Only the first four are, however, used as manufacturing stations at present. The gas-supply area of the Corporation is now approximately 98 square miles. The following are some interesting statistics connected with the gas undertaking:—

Capital spent on the undertaking		£3,869,143
Book value of ditto		£2,374,126
Gross revenue last year (1909-1910)		£879,434
Coals carbonized ,, ,,	tons	686,311
Gas made ,, ,,	cub. ft.	6,977,904,000
Maximum make of gas in 24 hours	,,	34,295,000
Maximum output of gas in ditto	,,	38,894,000
Total gasholder capacity	,,	44,376,000
Number of meters in use (Ordinary, 223,889; prepayment, 49,957)		273,846
Number of gas-stoves on hire and loan		67,802
Number of gas-engines in use		1,596
Total brake horse power		19,027

THE GAS-WORKS.

In view of what has already appeared in the "JOURNAL," it is not necessary to give a detailed description of the works.

Provan.—These works were designed for four sections, each capable of producing 12 million cubic feet of gas per day. Only the first section has, however, been constructed; but offices and workshops have been erected for the complete works. The coal-stores have a capacity of 50,000 tons. There are two retort-houses, 390 feet long by 78 feet wide, each containing 720 retorts, built in regenerative settings of twelves. They are 23 in. by 16 in., Ω-shaped, and 9 feet long over all. The fuel gas by which they are heated is generated in large gas-producers placed outside the retort-houses; the gas being conveyed to the settings through steel mains lined with fire-bricks. The charging and drawing machines are of the Arrol-Foulis type, worked at a hydraulic pressure of about 500 lbs. per square inch. The condensers are of both the atmospheric and water-tube type. The former are constructed of 18-inch steel tubes, and the latter (four in number) were made by Messrs. Kirkham, Hulett, and Chandler, Limited. Each is able to deal with 3 million cubic feet of gas per 24 hours. There are eight of Waller's patent exhausters, in four sets of two, each set being driven by a vertical steam-engine. Each exhauster is capable of passing 120,000 cubic feet of gas per hour. Four of Walker's ammonia scrubbers have been erected, each capable of dealing with 3 million cubic feet of gas in 24 hours; and two of Holmes's rotary brush scrubbers have been installed for the cyanide plant. The purifier-house is 503 feet long and 85 feet wide, and contains 24 purifiers, each 38 feet long, 27 feet wide, and 5 ft. 5½ in. deep. Lime is used exclusively. Three station meters have been erected, each capable of passing 200,000 cubic feet of gas per hour. There are two three-lift gasholders, of the same dimensions; the capacity of each being 8,500,000 cubic feet. The outer lift is 280 feet diameter and 50 feet deep; the middle lift, 276 ft. 10½ in. diameter and 50 feet deep; and the inner lift, 273 ft. 9 in. diameter and 51 feet deep. The tanks are of brick, 284 feet diameter and 51 feet in depth. Within the governor-house are installed two Parsons turbo-exhausters, for sending the gas down through a high-pressure main to the holders at the Dalmarnock station. Each exhauster is capable of dealing with 780,000 cubic feet of gas per hour, working with a difference of pressure of 24 inches of water between the inlet and outlet. The make of gas at these works last year was 2394 millions.

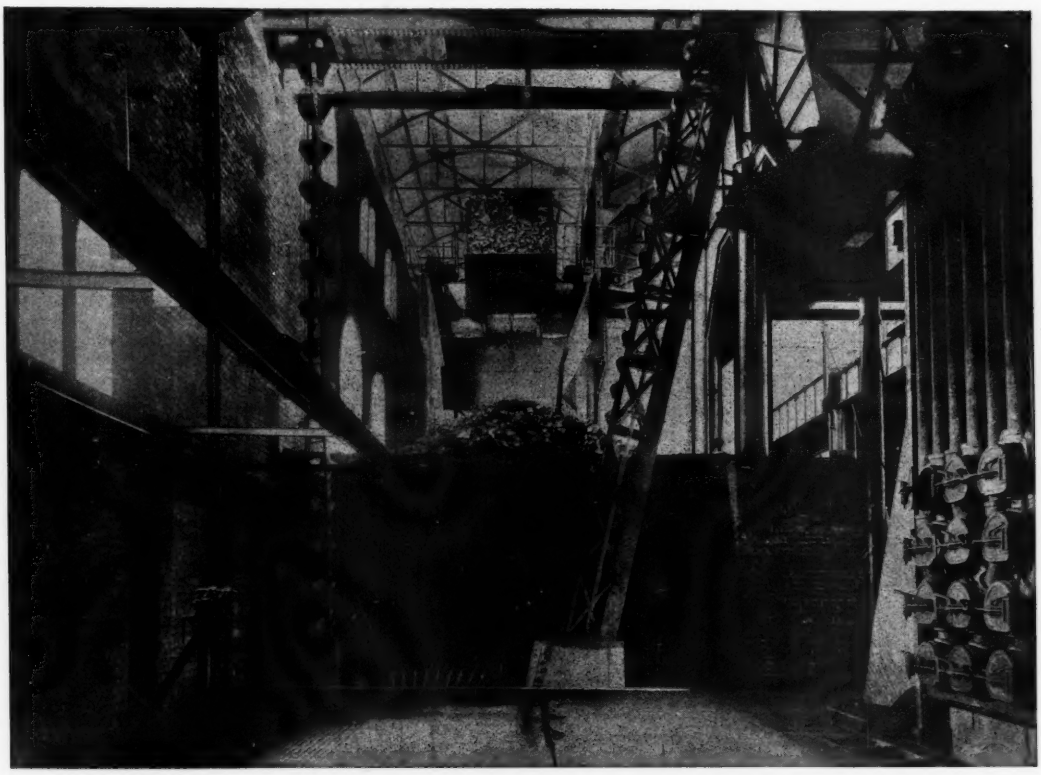
Dawsholm.—These works cover an area of 42 acres; and, as already stated, their capacity is 18 million cubic feet per day. No. 1 retort-house originally contained 832 retorts, set in ovens of eight, heated by both internal and external producers placed in front of the benches; but 240 of them have been cleared away to make room for six benches of verticals, containing 144 retorts. No. 2 retort-house contains 512 retorts in settings of eight, heated by internal producers. No. 3 retort-house has 768 retorts, set in ovens of twelve. All the retorts are of a uniform size, 21 in. by 15 in., Ω-shaped, and 9 feet long over all, set back to back in the ovens. Stoking machinery of the Arrol-Foulis type, working at a pressure of 450 lbs. per square inch, is installed in all the retort-houses. There is storage for 50,000 tons of coal. The condensers are of the atmospheric type, formed by 12-inch cast-iron pipes placed vertically. There are seven sets of exhausters, all of the rotary type; one vertical steam-engine driving every two exhausters. The ammonia scrubbers are those supplied by Messrs. C. & W. Walker, of the vertical type, all fitted with tar-extractors in the bottom sections. For the cyanide plant, Holmes's rotary scrubbers have been erected. There are eleven sets of purifiers in all—viz., six sets of four boxes, each 25 feet square; three sets of four, each 25 ft. by 30 ft.; and two sets of four, each 25 ft. by 36 ft. There are seven station meters, placed in two houses, four of them have each a capacity of 100,000 cubic feet, and the others of 120,000 cubic feet each, per hour. There are eight gasholders—four two-lift and the others three-lift; the total storage capacity being 16,130,000 cubic feet. The make of gas at these works last year was 2544 million cubic feet.

Tradeston.—These works, which are situated on the south side of the city, cover an area of about 15½ acres. Their present productive capacity is 10 million cubic feet per day; their maximum make, 9,393,000 cubic feet (1232 retorts); and their storage capacity (four holders), 7,350,000 cubic feet. The retort-house and coal-store form a block measuring 301 feet long and 322 feet wide. There are four retort-benches, set parallel with each other. Two have 16 through ovens of eights, and the others have 15 through ovens of twelves. The retorts are all the same size—viz., 21 in. by 15 in., Ω-shaped, and 9 feet long, set back to back, and heated on the regenerative system by semi-internal gas-producers. A complete installation of Arrol-Foulis charging and drawing machinery, worked by hydraulic pressure of 450 lbs. per square inch, is fitted to all the benches. The coal-store has a capacity of upwards of 14,000 tons. The condensers are of the atmospheric type, and consist of twelve sections of 9-inch and eight of 12-inch pipes. There are four sets of two exhausters, each set being driven by a vertical steam-engine, placed between them. Each exhauster is capable of passing 100,000 cubic feet of gas per hour. There are four ammonia scrubbers, each capable of dealing with 2½ million cubic feet of gas per 24 hours. The purifier-shed is 350 feet long and 100 feet wide, in two spans, and contains four sets of purifiers, each consisting of four cast-iron boxes, 35 feet square. Lime is the purifying agent; and it is burnt in the kilns within the works. The station-meter house is 107 feet long and 34 feet wide, and contains four station meters, each capable of registering 120,000 cubic feet of gas per hour. Seven mains leave the works, varying in size from 18 to 30 inches diameter. The four gasholders have a combined capacity of 7,350,000 cubic feet. There are three locomotives of the ordinary 4 ft. 8½ in. gauge, and six of 2-feet gauge, for working the traffic. The make of gas last year was 2039 million cubic feet.

Dalmarnock and Temple.—The Dalmarnock works (formerly the property of the City and Suburban Gas Company) have plant of an early type, capable of manufacturing about 7 million cubic feet of gas per day. No gas is, however, made in these works. The gasholders have a storage capacity of 4 million cubic feet, and are filled through a 36-inch main leading direct from the Provan works. The Temple works (formerly belonging to the Partick, Hillhead, and Maryhill Gas Company) were capable of producing about 2 million cubic feet of gas per day. They are now, however, worked and maintained only for experimental purposes. A large installation of plant for the manufacture of oil gas is still intact, but not required. A trial setting of vertical retorts has been erected at these works, as there was every facility for testing this system of carbonizing. Four retorts 20 feet long are in use; one retort being dealt with at the beginning of each hour.

WORKSHOPS.

These are situated in Walls Street and Stirling Street, in the centre of the city. The buildings, which are three storeys high in Walls Street and four storeys in Stirling Street, cover an area of 2477 square yards. In the buildings fronting Walls Street, the basement is used as a meter warehouse; and on the first floor are the offices and fitting department. The plant in the fitting-shop consists of screwing, pipe-cutting, drilling, and grinding machines, which are driven by an 11 B.H.P. gas-engine. The meter-repairing department, occupying the second and third floors, is fitted with all the necessary benches for tinsmiths carrying out repairs to the meters, and is equipped with proving-tables and holders for testing purposes. During the year ended May, 1910, upwards of 32,800 meters were repaired and overhauled



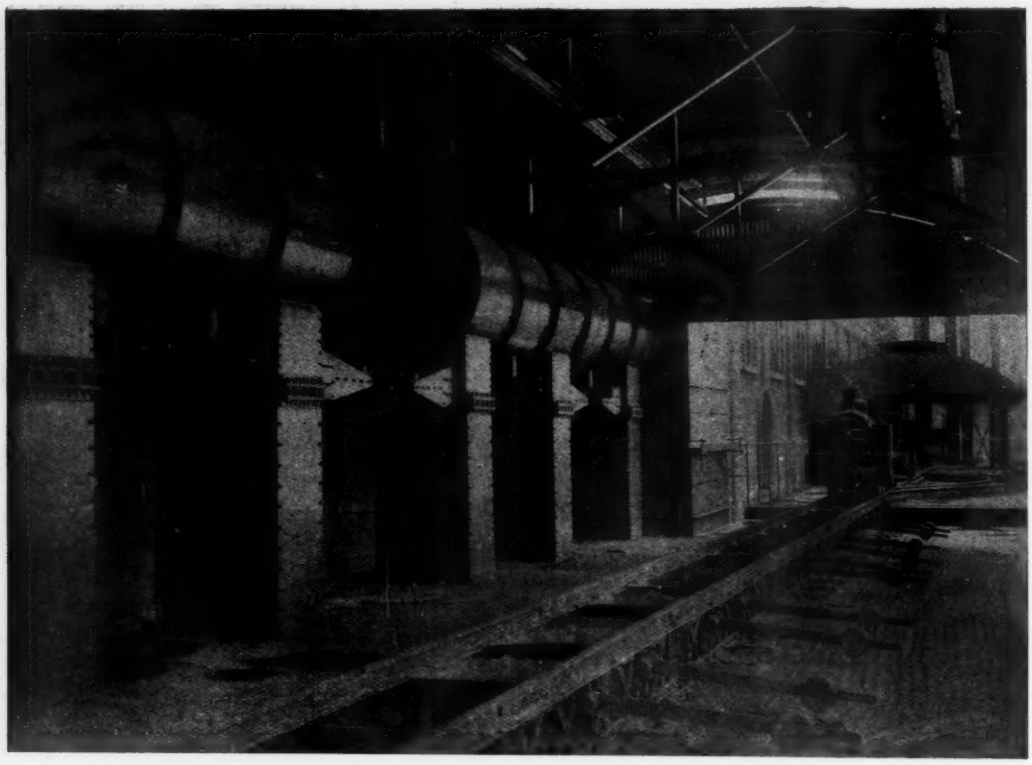
COAL-HOPPERS, ELEVATOR, AND WAGGON-TIPPING MACHINE.

in this department. The number of men employed is 174; comprising tinsmiths, brass-finishers, and labourers. In the buildings fronting Stirling Street, the basement and first floor are utilized as a general store for the materials required for the stove, fitting, and street mains departments, both for outside and inside jobbing; also the offices of the street mains department are situated on the first floor. The stove repairing and cleaning shop occupies the second floor. The plant in this department includes a polishing-machine, lathes, guillotine for the use of tinsmiths, and a drilling-machine, driven by a 6 B.H.P. gas-engine. The number of cookers, grillers, &c., repaired and overhauled during the last financial year was 15,800. On the third floor are the painters' and joiners' workshops; a portion of the flat being reserved for the slot-meter repairers. The cookers, &c., after having been cleaned and repaired, are stored on the fourth floor. The exigencies of the Scottish removal term on the 28th of May necessitate several thousand cookers, &c., being kept in stock for this period. The Government Meter-Testing Offices are situated very conveniently to the meter-repairing department of the Corporation; being accommodated in a portion of the building fronting Walls Street.

Show-Rooms.

These (four in number) are situated in the city and suburbs. The principal show-room, in Sauchiehall Street, consists of a basement and two upper floors; the former being used as a store and despatch warehouse. On the first floor are the order department and offices. The greater part of this flat is devoted to the

INTERIOR OF THE RETORT-HOUSE, SHOWING THE CHARGING MACHINE.

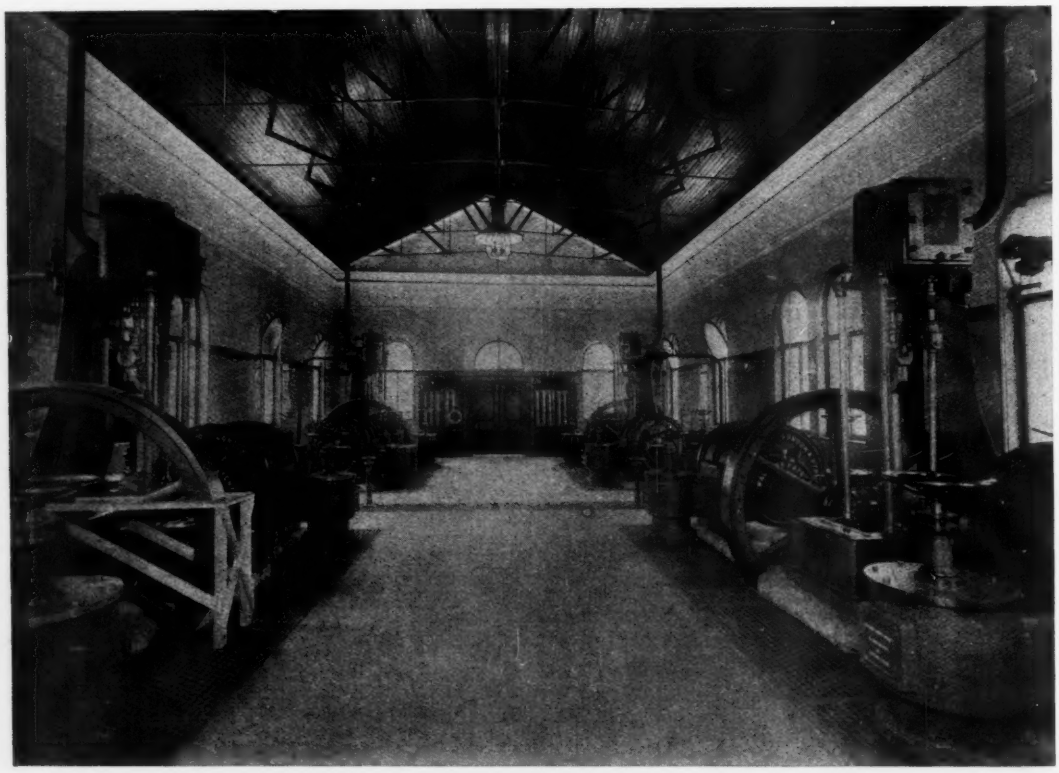


CHARGING STAGE OF THE FUEL-GAS PRODUCERS.

display of all the latest types of gas cooking and heating stoves, &c.; also of working exhibits of water-heating appliances. The upper floor is set out as a complete furnished house, with dining and bed rooms, kitchen, bath-room, and laundry, where the latest styles of gas-fires and water-heaters are shown in operation.

Electricity Department.

There are two main electricity generating stations in the city—Port Dundas and St. Andrew's Cross. The following are some particulars of the Port Dundas works: There are 23 water-tube boilers—nineteen of Babcock and Wilcox type, and four of the Stirling type. The Babcock and Wilcox boilers vary in size and design. The ten smaller land-type boilers have each 4020 square feet of heating surface, with a grate area of 63 square feet. The larger land-type boilers have each 6180 square feet of heating surface and 100 square feet of grate area. The Stirling boilers are of the same size as those last named. The Babcock and Wilcox marine boilers have each 6000 square feet of heating surface, with a grate area of 150 square feet. The working pressure of the boilers is 200 lbs. per square inch, and the steam is superheated. The boilers discharge their gases into four of Green's economizers; the total number of tubes being 2488. The plant in the engine-room may be divided into two classes—one for generating three-phase alternating current at 6500 volts 25 periods, and the other for generating direct current for a three-wire system with 500 volts across the outers. The are four turbo-alternators of 4000 H.P. capacity, and one similar set of 5000 H.P. capacity; the turbines being of the Parsons type, made by Messrs.



INTERIOR OF THE EXHAUSTER HOUSE.

Willans and Robinson, and the alternators by Messrs. Dick, Kerr, and Co. and the British Westinghouse Company. The speed of all the turbines is 750 revolutions per minute. The number of blades in the largest turbine is 85,000. The direct-current generators are by various makers; and all are coupled to reciprocating engines of sizes as follows: Two of 2400 H.P each, at 180 revolutions per minute; three of 1200 H.P. each, at 230 revolutions per minute; one marine type, 1000 H.P., at 100 revolutions per minute; one Corliss type, 750 H.P., at 150 revolutions per minute; and two small high-speed sets, one of 400 H.P. and the other of 200 H.P. This gives an aggregate of 30,000 H.P. Surface condensing plant of suitable capacity, with motor-driven air and circulating pumps, is attached to each turbine and engine. In the middle of the continuous-current section of the engine-room, one 1000 kilowatt motor generator and two 500 kilowatt rotary converters are installed for the purpose of equalizing the load and the power factor on the turbo-generators, as well as to ensure efficient results. There are also in this part battery boosters and motor balancers for the three-wire system.

WATER GAS AT THE GENEVA GAS-WORKS.

By M. Des Gouttes.

[A Paper read before the Société Technique du Gaz.]

The present paper does not purport to describe the manufacture of carburetted water gas, nor to set out its advantages. I only want, at the request of the President, to give some information about the working results obtained at Geneva in the manufacture of carburetted water gas.

The plant was put up in 1901, and is of the Humphreys and Glasgow type; the gas being carburetted while hot with mineral oil. The producing capacity is from 10,000 to 12,000 cubic metres per 24 hours. Generally it is only at work for nine or ten hours per day, during the daylight. Two men are enough for the manufacture, except during the first hour in the morning, when the clinkering of the generator is done. This requires four men, but only for an hour at the most. The carburetted water gas is sent into a gasholder of a working capacity of 3500 cubic metres. After the holder, it goes through a meter and is mixed with the coal gas before the foul main. This meter enables us to pass into the coal gas exactly the amount of water gas we desire. Both gases pass together through the foul main, exhausters, condensers, washers, and purifiers, and become thoroughly mixed. The water-gas plant actually makes 550 to 600 cubic metres per hour; the make depending on the state of the clinker on the generator fire-bars, which, in turn, depends on the nature of the coke used. Generally we use coke from St. Etienne coals, containing about 15 per cent. of ash. We find it beneficial, when working ten hours, to clinker the furnace at midday. On an average, we regularly make 5000 cubic metres of carburetted water gas per day—that is, during the ten hours of daylight; and owing to the 3500 cubic metre gasholder, we mix through the day and night a regular quantity of carburetted water gas with the coal gas. By this means, in normal working we have a constant gas, which is an important point for the consumers.

It is obvious that in some instances—such as the letting down or lighting up of a retort-bed, or according to atmospheric conditions—the proportion of carburetted water gas varies. This is one of the well-known advantages of the process. But, in general, we try to have a gas as constant as possible by mixing with the coal gas always the same proportion of carburetted water gas. This proportion is, as a rule, 15 per cent. We never exceed this figure—on the one hand, so as not to increase the toxicity of the gas, and on the other, so as not to alter the gas combustion in hot-plates or cookers. It is true that the latter inconvenience can be remedied by enriching the gas by a larger use of oil, and by increasing the outlet pressure; but this increase is not always easily made effective at the point of consumption, more especially where the mains are too small.

As for the amount of carbonic oxide, there is no need to exaggerate the effect of carburetted water gas in this respect. Indeed, we admit that pure coal gas contains 8 per cent. of carbonic oxide, and carburetted water gas 30 per cent. A mixture composed of 85 per cent. of coal gas and 15 per cent. of carburetted water gas will contain 11·3 per cent. of carbonic oxide—that is, only 3·3 per cent. more than pure coal gas. If coal gas contains 9 instead of 8 per cent. of carbonic oxide, the same proportionate mixture of the two gases will contain 12·15 per cent. of carbonic oxide, or only 3·15 per cent. more than pure coal gas. These differences are of slight importance.

The cost of manufacture of carburetted water gas at Geneva is considerably less than that of coal gas. This difference is due either to the low price of the oil for carburetting or to the rather high price of coal. The oil that we use is mineral oil from Galicia. For some years its price has been much reduced. To-day, it costs 7·685 frs. per 100 kilos. delivered into the tank at the works, including wharf dues and customs. The import duty into Switzerland is 50 c. per 100 kilos., *plus* a supplement of 15 per cent. on the net weight of the tank waggon. It is this comparatively low import duty which enables oil to be used in Switzerland for carburetting gas, while the much higher duties in France render its use more difficult. The oil has a specific gravity of about ·86, and a calorific power of 10,000 calories.

We use from 420 to 440 grammes of oil, and from 530 to 600 grammes of coke per cubic metre of carburetted water gas. We make a gas of from 19 to 22 Hefner units, measured in the argand burner, with a consumption of 150 litres per hour, and a calorific power, reduced to 15° C. and 760 mm., of 5000 calories at the least. This gas is considerably richer, both in candles and in calories, than simple coal gas. Carburetted water gas, therefore, improves to a great degree the gas we send to our consumers. Its use saves employing boghead or cannel coal.

I have compared the net cost of the two gases, not taking into account the costs common to both. We do not include purification, nor the cost of maintaining the works, nor of distribution, or management or any sinking fund. All these expenses are common to both. We only calculate the net cost of the two gases in the same works, at the moment when they mix together at the inlet to the foul mains.

Coal Gas.—We take into account the cost of coal, deducting the receipts from bye-products (coke, tar, and ammoniacal liquor). We include labour for the retort-house, producers, coal and coke conveying, collecting the ammoniacal liquor, and the price of the coke used in the producers. For the year 1910, the figures were:

	Per Cubic Metre. Centimes.
Cost of coal (bye-products deducted)	6·169
Labour (retorts, producers, coal, coke, liquor)	1·131
Coke for producers (at lowest sale price)	1·536
Total	8·836

The make of coal gas in 1910 was 10,656,350 cubic metres.

Carburetted Water Gas.—We take into account the cost of oil, the expense for coke (reckoned at the lowest sale price), labour, and steam from the works' boiler. As the boiler is used for purposes other than for the manufacture of carburetted water gas, we have had to take a figure for this special purpose, and we allow an expenditure of 250 grammes per cubic metre of carburetted water gas. For the year 1910, the figures were:

	Per Cubic Metre. Centimes.
Cost of oil	3·701
Cost of coke	1·669
Labour	0·359
Cost of steam	0·275
Total	6·004

The carburetted water gas is therefore 2·832 c., or 32·05 per cent., cheaper than coal gas.

The following table shows the relative net prices of the two gases during the last four years, arrived at as stated above:—

—	1907.	1908.	1909.	1910.
	Cent.	Cent.	Cent.	Cent.
Net cost per cubic metre of coal gas	7·660	8·684	8·306	8·836
" " " carburetted water gas.	7·181	7·095	6·696	6·004
Difference in favour of carburetted water gas	0 479	1·589	1·610	2·832
Percentage difference in favour of carburetted water gas	6·25	22·39	24 04	32·05
	Frs.	Frs.	Frs.	Frs.
Cost per ton of coal at works	32·195	35·158	34·664	33·50
Lowest sale price of large coke per ton	33·195	30·50	29·50	27 75
Cost per 100 kilos. of Galicia oil at works	10·796	10·702	9·6706	8·8934
Oil used per cubic metre of carburetted water gas (kilos.)	0·449	0·443	0·430	0·417
Coke used per cubic metre of carburetted water gas (kilos.)	0·523	0·574	0·643	0·602
Yearly average of calorific power of carburetted water gas (calories)	5033	4999	5030	5405
Lighting power of carburetted water gas. (Hefner units)	19·33	19·50	19 50	23·25
Oil used per candle and per cubic metre (grammes)	23·20	22·70	22·05	17·90

The table shows that the difference in cost between the two gases varies considerably according to the cost of coal and oil. At Geneva, the carburetted water gas is constantly cheaper than coal gas on account of the high price of coal and the low price of oil. As, in addition, carburetted water gas is considerably richer than coal gas, we appreciate at its fair value this process of gas manufacture, which offers important advantages and renders considerable services in the management of a gas-works.

Newcastle Gas Company and the No. 2 Burner.—During his stay in Glasgow last week, Mr. T. Hardie, the Chief Engineer of the Newcastle-upon-Tyne Gas Company, received a message from the Secretary (Mr. Thomas Waddom), informing him that the Board of Trade had approved of the adoption by the Company of the "Metropolitan" No. 2 burner as the standard in place of the one now in use. Further reference to the matter will appear next week.

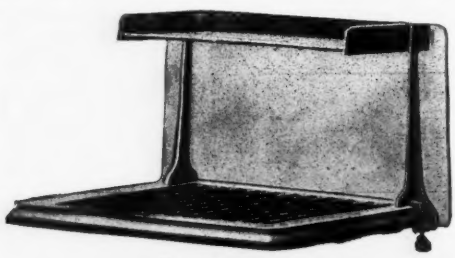
THE "NONPAREIL" SUN-BURNER.

MEMBERS of the Institution of Gas Engineers who attended Professor Bone's lecture last Tuesday evening will remember that the sun-burner used in the hall attracted considerable attention. Particulars respecting it may therefore be interesting. It was one of the "Nonpareil" burners manufactured by Messrs. James Milne and Son, Limited, of Edinburgh, the special advantages claimed for which are that it possesses the ventilating capacity of the old-fashioned flat-flame sun-burner, while it develops a much higher candle power, at less cost, than can be obtained with any existing system of lighting. The burner used at the lecture consisted of 28 separate inverted incandescent gas-burners, each adjusted to consume 2·8 cubic feet of gas per hour at 20-10ths pressure; so that the total hourly consumption was less than 80 cubic feet. The construction of the burner permits of the gas and air being heated before uniting in the bunsen tubes—thus ensuring efficiency in combustion. The illuminating power claimed for the burner is 2100 candles. It has been for six months in use in public halls, churches, &c., without requiring the renewal of a single mantle. In several cases, the "Nonpareil" has replaced sun-burners with flat-flame jets which had a total consumption of 375 cubic feet per hour, compared with its 80 cubic feet; thus effecting a saving of upwards of 75 per cent. in gas, with the additional advantage of producing a light of much greater efficiency. The burner can, without any difficulty, be lowered for the replacement of mantles and cleaning, and afterwards restored to its position by means of a wire cord and winch. Other claims put forward for the burner are the following: Entire absence of shadow; no glass to keep clean or to break and fall upon an audience; and greatly improved ventilation. The control-tap can be placed in any part of the hall; thereby enabling the light to be switched off and on by means of special pilot or flash lights in the lamp. The burners are now being made in straight form, with any number of gas-burners, for the illumination of shop windows.

USEFUL COOKER ACCESSORIES.

ON many occasions during the twenty years or so that they have been engaged in the manufacture of gas apparatus, opportunity has been taken to draw attention to the efforts made by the Richmond Gas Stove and Meter Company, Limited, to benefit both the supplier and consumer of gas. The success that has attended these efforts may be fairly assumed to be due in no small degree to first-class workmanship, scientific knowledge, and the practical tests undergone by each piece of apparatus in the shops to ensure the highest working efficiency under ordinary conditions.

One of those additions which go to increase the utility and convenience of their gas-cookers, is the firm's plate-rack and splasher. Plates and dishes become warmed while resting on the rack; while the splasher, at the back of the cooker hot-plate, being enamelled, can be easily kept clean by the aid of a damp cloth.



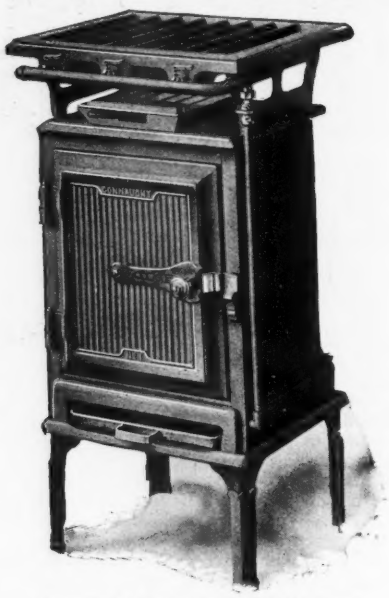
The "National."

Since its first introduction by the Company some five years ago, this accessory has undergone various improvements. Beginning with a simple rack only, with front supports and legs, it is now accommodated with the enamelled back-plate and a removable hood, and manufactured in two patterns—viz., the "National" and the "Universal." The "National," which is made in sizes to fit each individual cooker, is in every way a useful and efficient addition to any gas-cooker, and has a very large sale. But the steady and increasing demand for a plate-rack and splasher that would be interchangeable led to the introduction by the Company of the "Universal" pattern to supply this want. The particular point for gas undertakings about the "Universal" is the fact that the supports are so arranged as to enable one size to fit quite a large range of cookers of any make—thus obviating the trouble that might arise from having to stock a number of different patterns and sizes.

Another useful adjunct to which attention may be drawn is the adjustable stand for cookers requiring to be raised. This stand has been designed by the Richmond Company for medium-sized cookers; the object being to do away with the necessity of stooping on the part of the user. It can be adjusted in height from 3 to 5 inches in a very few moments. The top portion of the stand is treated with "Porcellanite" enamel, which should act as an inducement to the consumer to keep the cooker clean; while it is

The "Universal."

pointed out that the fact of the drip-tin being raised prevents an inflow of particles of dust from the floor surface, which might be drawn into the oven by the rising heat. The application of the adjustable stand is seen in connection with the "Connaught"



Connaught Cooker on Adjustable Stand.

cooker, introduced this season. This is a stove with three useful burners, including a grill, which is neatly designed. The total height before adjustment of the stand is 32½ inches, which can be increased by the patent adjustable legs to 36½ inches, or practically any height between these two figures. Already, we are informed, it has been adopted as a hiring cooker; and its claims to convenience and practical utility should make it popular.

"HOWLETT" INVERTED BURNERS.

THERE are several advantages attaching to the "Howlett" inverted incandescent gas-burner, which is of "all-British" manufacture—being made throughout in the works of Messrs. M. Howlett and Co., Hockley Hill, Birmingham. It is a service-

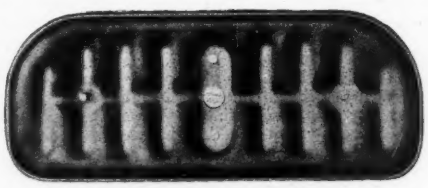
The "Howlett" Burner.

able and well-made burner, and can be had in patterns to meet different requirements—that is to say, there is the ordinary pattern for upright fittings, the reverse pattern for inverted fittings, and a pattern for side fitting. With it, one is informed, 25-candle power per foot of gas consumed can be obtained; and an important

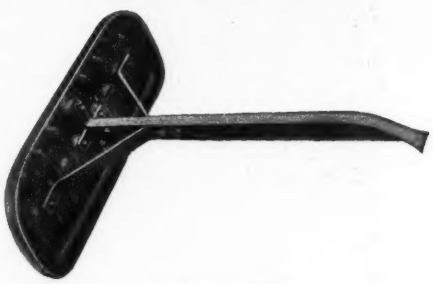
point is that it is silent. It is a non-corrodible burner, as it is fitted with an elbow of "Adamas" porcelain, which (being also detachable) can be taken off the burner and wiped perfectly clean. There are thus no loose bits to drop into the mantle. Then, again, when fixing, the burner (in consequence of the fact that it is made detachable) can be revolved or turned in any required direction, and set with an adjusting collar. For use with these burners, there is the Howlett "Perfect" gas-regulator, a neat and simple little arrangement whose function—and it is an important one—is to permit the adjustment of the supply of gas without in any way altering the pressure.

COAL STOPPERS.

ALMOST self-explanatory are the two illustrations given here of a useful little retort-house appliance to which attention has been drawn by the Central Engineering Company, of Sherbourne Road, Birmingham. This is an improved coal stopper, intended for employment in connection with inclined retorts, of which more than fifty thousand have been sold to Government and municipal and



Stamped Coal-Stop Plate.



Complete Stopper.

company gas undertakings throughout the country. The patent stamped plate is, it may be pointed out, made from special mild steel, and is suitable for any size or shape of retort. Plates of this style, it is urged, will not buckle nor get out of shape; and they have four times the life of plain plates made from much stronger metal. These coal-stops are, we learn, supplied solid welded and rivetless.

Abertillery and District Water Supply.—At the meeting of the Abercarn District Council last Wednesday, Mr. F. J. Matthews reported that the Abertillery and District Water Board had received an offer from a private syndicate who were prepared to purchase the undertaking at 50 per cent. higher price than the cost to the local councils. This was testimony to the enterprise of the Board, who had considered that if the undertaking was worth the amount to a syndicate it was worth much more to the ratepayers.

Folkestone Public Lighting.—The Lighting Committee of the Folkestone Town Council report having considered estimates for lighting 11 suspension lamps, to be erected in the Shorncliffe Road, from the Folkestone Electric Supply Company, Limited, for lamps of 200-candle power each; from the Folkestone Gas Company, for lamps of 330-candle power each; and from the Borough Surveyor, for lamps of 200-candle power each. After considering these estimates, the Committee expressed the opinion that it would be more economical to light the lamps with gas of 200-candle power each; and they accordingly instructed the Borough Surveyor to carry out the work.

New Issues of Gas and Water Capital.—Under instructions from Directors, Messrs. A. & W. Richards sold last Tuesday, at the Mart, Tokenhouse Yard, E.C., some new issues of capital of gas and water companies. The first lots consisted of £10,000 of "D" capital water stock of the Barnet District Gas and Water Company, ranking for a maximum dividend of 7 per cent., but carrying £5 12s. per cent. as from the 1st prox.; and they were all sold at £116 10s. to £117 10s. per £100. A new issue of £5000 of ordinary 5 per cent. stock of the Dartford Gas Company was placed at from par to £102; some 4 per cent. perpetual debenture stock of the Company fetching £95 to £96. Some 4 per cent. perpetual debenture stock of the Great Yarmouth Water Company realized from £102 to £103 10s. per £100; while £4000 of new ordinary 7 per cent. stock (present dividend 4 per cent.) was sold at £91 5s. to £92. The final lots consisted of a small issue of new ordinary £10 shares in the Westgate and Birchington Water Company, ranking for a maximum dividend of 7 per cent. (present dividend 5¼ per cent.); and they were all sold at from par to 10s. premium.

CORRESPONDENCE.

[*We are not responsible for opinions expressed by Correspondents.*]

Analyzing Small Samples of Gas.

SIR,—Referring to Mr. Hewett's letter on this subject in the last number of the "JOURNAL" (p. 752), I may say that apparatus with which the gas analyses recorded in the article by Mr. Burgess and myself were made is fully described in the "Journal of the Society of Chemical Industry," Vol. XXVII. (1908), p. 10, under the title "An Accurate Form of Gas Analysis Apparatus for Commercial and other Purposes," by W. A. Bone and R. V. Wheeler [see also "JOURNAL," Vol. CI., p. 160]. Further details regarding the method of analysis employed when dealing with small quantities of coal gas are given in the "Record of the First Series of the British Coal Dust Experiments" issued by the Mining Association of Great Britain in 1910.

In answer to the specific point mentioned in Mr. Hewett's letter, I may say that the apparatus is of the "constant volume" type, and that 2·5 c.c. occupy about 80 "volumes" of the measuring tube.

Altofts, Yorks., June 14, 1911. R. V. WHEELER.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

The following Bills have received the Royal Assent: Blackburn Corporation Water Bill, Chesham and District Gas Bill, Chichester Gas Bill, Ely Rural District Water Bill, Felixstowe and Walton Water Bill, Luton Water Bill, Slough Urban District Water Bill, Swinton Urban District Council Bill, Tamworth Gas Bill, Warrington Corporation Bill, Weston-super-Mare Gas Bill.

HOUSE OF COMMONS.

The following further progress has been made with Bills:—

Lords Bill read a second time and committed: Swansea Gas Bill.

Lords Bills reported with amendments: Ashborne and District Gas Bill, Harrogate Corporation Bill.

Bills read the third time and passed: Enfield Gas Bill [Lords], Halifax Corporation Bill, Hastings Corporation (Water and Finance) Bill [Lords], Local Government Provisional Orders (Gas) Bill, Luton Gas Bill [Lords], Thames Conservancy Bill.

The Swansea Corporation have petitioned against the Swansea Gas Bill [Lords].

ASHBORNE AND DISTRICT GAS BILL.

The Bill promoted by the Ashborne District Gas Company came before the Ways and Means Committee of the House of Commons on Thursday last as an unopposed measure. Mr. WHITLEY, the Deputy-Chairman, presided.

Mr. CROWTHER (Parliamentary Agent) stated that the object of the Bill was to dissolve and incorporate the Company, with the usual parliamentary powers. The existing Company and its predecessors had supplied Ashborne with gas for a period of seventy years; and during the whole of this time there had been no complaints. The Bill authorized the Company to supply gas within the existing area, and to the extended district of Mapleton, Stirston (Derbyshire), and Mayfield (Staffordshire). The Bill was opposed in the Lords by the Urban District Council, who raised the usual questions of the price of gas, capital, and purchase. The measure was fully examined, and certain modifications were made in it. In the Commons, the District Council sent another petition against the Bill; but an agreement had been come to, and a purchase clause would be inserted. The capital was £20,000, with an 8 per cent. dividend on it; and the additional capital proposed was £10,000, which would keep the Company going for a period of ten or twelve years. The price proposed was 3s. 4d., which was the present rate. In the seventies, the price was 5s. 5d.; so that it had been substantially reduced. The Local Government Board made a report on the Bill; but the points raised were complied with in the House of Lords, with the exception of that in relation to the sale and lease of lands. The Local Government Board wanted the Company to incorporate the Lands Clauses Acts; but the land affected was ground acquired in the ordinary way by the Company, and therefore these provisions were not necessary. There had been a letter from the Home Office to the Chairman of the Committee; and so far as the merits of the Home Office intervention were concerned, the question involved had been settled.

The Committee expressed their objection to the practice of the Home Office in communicating merely with the Chairman of the Committee.

The clause inserted at the instigation of the Home Office provides that, instead of a differential charge of 6d. per 1000 cubic feet, the charge should be calculated according to the quantity of gas consumed, and that in no case should it exceed 6d. per 1000 cubic feet.

The Bill was ordered to be reported to the House.

A short time ago, the Cannon Iron Foundries, Limited, of Deepfields, near Bilston, put into the County Asylum, Stafford, an extensive installation of gas cooking apparatus. The work was carried out under the personal supervision of Mr. Hubert Pooley.

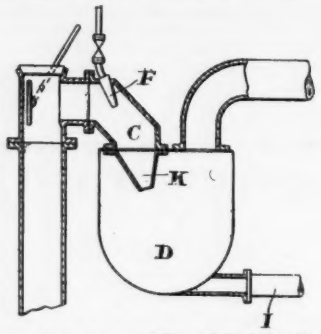
REGISTER OF PATENTS.

Extracting Tar from Hot Gases.

HUESSENER, K., of Upper Thames Street, London; SCHAEFER, J., of Hochst on Main; and HENSS, E., of Soden, am./Taunus, Germany.

No. 6899; March 18, 1910. Date claimed under International Convention, Sept. 2, 1909.

In recent methods proposed for the extraction of tar from hot distillation gases (the patentees point out), the gas has to be conducted from the distillation chamber to a separate apparatus; but by their process "all this separate apparatus is dispensed with and the extraction of tar in apparatus separate from the distillation chamber is avoided."



Huessener, Schaefer, and Henss' Hot Tar Extractor.

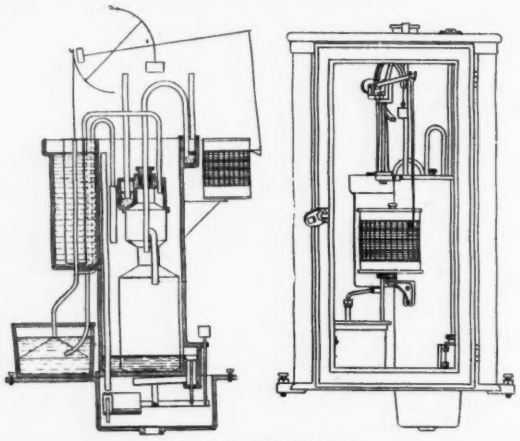
The apparatus suggested consists of the usual ascension pipe from the retort or distillation chamber, the delivery end of which connects with the hydraulic main D. The connection E leads from the hydraulic main to the hot-gas main. I is the tar-outlet pipe; and F the tar-sprayer. The tar is introduced under pressure to the nozzle into the delivery end of the ascension pipe, which has a nozzle K. A "thorough mixture of the hot distillation gases and the washing medium" is said to be obtained in the end pipe C and the hydraulic main—"thus eliminating the tar to the last traces from the hot gases."

Automatically Analyzing a Gaseous Mixture.

WOODROFFE, F. K., of Newton, Chester.

No. 11,521; May 10, 1910.

This apparatus is said to be especially serviceable in connection with the determination of the proportion of carbonic acid formed by the combustion of coke, coal, oil, or gas; and it has primarily for its object "to render apparatus of this kind less delicate and less troublesome in use than those at present employed, and, generally, to provide one which will not easily be put out of order, or become deranged or defective, and will stand without deterioration or disturbance of proper action the kind of usage which is bestowed upon such appliances by the class of person in charge of apparatus in connection with which such appliances or instruments are used." It also has for its object to render it capable of being readily inspected and cleaned, and the different parts taken apart for this purpose, and readily put back.



Woodroffe's Gas Analyzer.

The apparatus consists of an outer water-containing vessel, within which is a gas-containing vessel, and parts connected with it; while outside this water-containing vessel there is a vessel adapted to be filled with an absorbent for the gas—say, a solution of caustic potash—and having within it a bell or hood into which the gas is passed. Above this bell, there is another vessel for holding water, and having a bell in it, into which the gas from the absorber is admitted from the bell below, and the movement of which in the water is adapted to operate the recording instrument. There is also connected with the main vessel another water-sealing vessel containing liquid, which communicates with the interior of the main gas-containing vessel by a pipe, one end of which dips into the liquid in it. This latter vessel, and the movable bell vessel, are connected to the main water-containing vessel; and the level of water in all of them is, by suitable connections, arranged and adapted to be maintained at a constant or common point. In connection with the primary water-containing vessel, there is an automatic means for supplying water to it, and for discharging it.

In action, water in a trickle is admitted gradually to the water-containing vessel and to the gas-containing vessel; and it is so supplied until it reaches a certain height, when it passes by an overflow pipe from a point near the upper end of the water-vessel to a small pan connected with the water automatic supply and discharge apparatus, which is carried on a balanced lever or the like. When the water in this pan overbalances the lever, the movement of the lever lifts the valve—say, in the bottom of the water-containing vessel—and allows the water, both in this vessel and in the gas-containing vessel, to discharge quickly. A part of this water as it is discharged is led into the small pan, and thus keeps it in the position to which it has been moved, until the main water-vessel is emptied to the level of the valve, when the flow ceases, and the remaining water in the small pan is discharged by a small syphon in it. When so discharged, the balance weight of the appliance overbalances the pan; and so the main water discharge valve is again closed.

During this discharge of the water, the gas to be analyzed is drawn in through a pipe which dips into the water seal-chamber at the upper part of the gas container or vessel, and so this gas-vessel becomes filled with gas. As the water rises in the main water-vessel and the gas-vessel, due to the valve referred to being now closed, a part of the gas in the gas-vessel will be forced up and discharged through a pipe depending down into it for a certain distance, and passed (say) through a stuffing-box in its upper end or cover. This gas is conducted through a flexible connection and another downpipe into one of the sealing or trapped chambers connected with the main vessel referred to, and thence away through a discharge pipe into the atmosphere. But when the water level in the gas-chamber reaches the lower end of the pipe, the escape by way of it is closed, and the remainder of the gas in the upper part of the gas-vessel—between which and the lower part there may be a narrow neck or portion—is forced by the rising water through the pipe extending from this vessel, or a branch thereon, to the absorbing vessel bell referred to, and through the absorbent in this tank under the dome or bell therein; whence it passes by the other pipe referred to into the movable floating bell in the sealed float bell chamber, causing the bell to rise, and thus actuate the recording mechanism.

After the gas is discharged, and the water in the main water-vessel has risen to a certain height, it operates the main valvular apparatus referred to, and, in falling, it uncovers a depending pipe within the water-vessel, which is connected with the pipe extending between the absorber dome or bell and the floater bell moved by it, so allowing the gas in this floater bell to escape, and the bell to return to its lowest position.

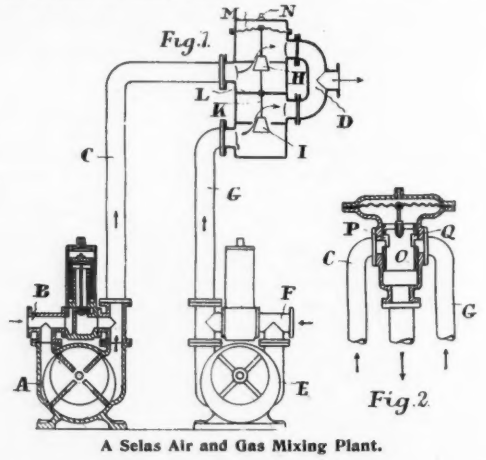
Gas and Air Mixing Plants.

LAKE, H. W.; a communication from the SELAS-GESELLSCHAFT M.B.H., of Berlin.

No. 21,508; Sept. 15, 1910.

This invention relates to gas and air mixing plants of the class in which there is employed a compressor for the gas, and a separate compressor for the air, and in which the quantities of gas and air delivered to the service-pipe are automatically regulated in proportion to the consumption, by valves or equivalent obturating members which are under the control of the service pressure and which operate to vary the size of the ports through which the compressed air and the compressed gas pass. The chief object of the invention is to obviate certain irregularity found in plants of this class.

The means employed for varying the size of the ports through which compressed gas and the compressed air respectively pass comprise two valves mechanically connected together and controlled by a single member subject to the service pressure; the valves being preferably mounted on the same stem and controlled by a flexible diaphragm or the like, also mounted on the same stem, as already proposed in other classes of gas and air mixing plants.



A Selas Air and Gas Mixing Plant.

Fig. 1 is a sectional elevation of plant having a separate valve for each compressor. Fig. 2 is a vertical section of part of a plant in which a combined gas and air regulating valve is used.

A is the compressor drawing gas through a socket B and forcing it through a conduit C into mixing-chamber D. E is the air compressor drawing air through a socket F and delivering it through a conduit G to the mixing-chamber D. The gas and air mixture is supplied to the burners or other appliances through a service-pipe, not shown. H is

the gas regulating valve interposed between the conduit C and the mixing-chamber D. Similarly, the air regulating valve I is interposed between the conduit G and the mixing-chamber D. The two valves H and I are rigidly connected together by the stem K, which is guided in the wall L separating the two valve chambers; a stuffing-box being employed, if necessary, for this purpose. M is a flexible diaphragm above the valve H. The service pressure of the gas and air mixture in the chamber D acts upon this diaphragm from below, while, by means of a port N, the pressure of the atmosphere acts upon it from above.

With a normal consumption, the valves H and I remain as shown in fig. 1. As soon as the consumption falls, and consequently the pressure in the mixing-chamber D rises, owing to the continuous rotation of the pumps A and E, the diaphragm M is forced upwards and gradually closes the valves H and I—the amount of port opening being inversely proportional to the pressure of the gas and air mixture. As both valves are controlled by the same diaphragm M, no difference in the displacement of the two valves can arise.

In the construction illustrated in fig. 2, a piston slide valve O is provided instead of the two valves H and I. This slide valve controls the gas-conduit C by means of the port P, and the air-conduit G by means of port Q; so that there is no necessity for employing stuffing-boxes or the like.

Illuminating by Incandescent Mantles.

GREYSON DE SCHODT, P., of Namur, Belgium.

No. 12,160; May 17, 1910.

The inventor proposes to take an upright bunsen burner fitted with an elbow or bend (or a group of same as circumstances may dictate), the two combined with an elongated chimney which permits of creating a sufficient draught for maintaining a single flame along the axis of a mantle open at both ends, and imparting to such flame sufficient rigidity for supporting the mantle during combustion, and, by means of a greater draught, producing intense incandescence of the entire surface of the mantle thus held without an inner support.

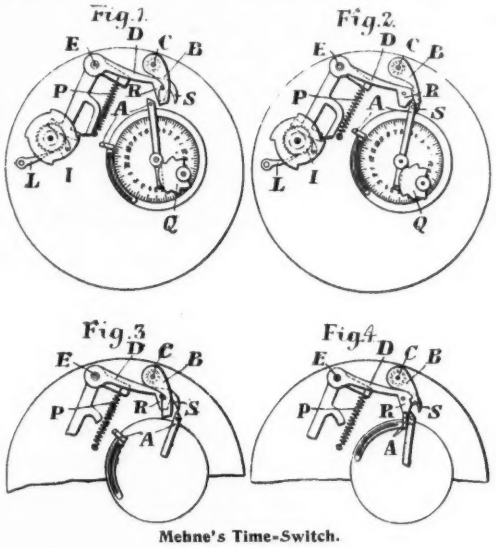
The invention formed the subject of a paper read before the Société Technique du Gaz en France last year—see "JOURNAL" for June 28, pp. 951-53.

Time Switches for Turning on and Off Gas-Lights.

MEHNE, J. G., of Schwenningen, Wurtemberg.

No. 2259; Jan. 28, 1911.

This invention relates to the apparatus for switching on and off electrical time switches described in patent No. 14,052 of 1909. In the apparatus described in this earlier patent, it was not possible to place the switching apparatus (for instance, in summer) entirely out of action, so that no operation of the actual switch apparatus could take place. By the present invention, this is provided for by a peculiar formation of the end of the switch lever, and also by the form of the rotating catches.



Mehne's Time-Switch.

Fig. 1 shows the arrangement before switching on. Figs. 2 and 3 explain progressively the return of the switch lever by the first catch. Fig. 4 shows the working of the catches when they are placed together.

The arrangement, so far as the catches are concerned, is the same as in the 1909 patent. The catches A are mounted on a revoluble disc; and one is intended for lighting and the other for extinguishing the gas. The catches then again act in conjunction with a switch lever D, which turns on a pivot E and acts on ratchet mechanism I L and so forth. The lever D is under the action of a spring P, and is held fast in position ready for operating by a pawl B, which turns on a pin C. By the present invention, the lever D has two teeth R S, which act alternately in conjunction with the catches A.

When the light is to be normally turned on and off, the first catch slips away beneath the tooth R, releases the pawl B, and the lever D (by reason of its spring) springs off—that is to say, the light is switched on. The first catch A in question here stands in the interval between the two teeth R and S. The catch then comes, for instance, by means of its inclined face, on to the second tooth S, and thereby again lifts the lever D until it is engaged by the pawl B, whereby it stands again in a position ready for the next switching operation, and the spring P is stretched. Now when the second catch A encounters it, the operation is repeated, and a switching again takes place—that is to say, the light is turned off.

Now if the two catches are placed together, no switching takes place. For this object the teeth R S are arranged in such a way and the catches have such a form that the switch lever D cannot spring off. The first catch A first again encounters the tooth R, when it then lifts the pawl B. The second catch A has in the meantime passed under the tooth R, so that the switch lever cannot drop off, although it is no longer locked by the pawl H. In the meantime, the first catch passes under the tooth S, releasing the pawl B, which, in turn, again locks the switch lever D; and in this way the second catch A can entirely move past without switching.

Separating Sulphuretted Hydrogen from Gases.

BURKHEISER, K., of Hamburg.

No. 22,335; Sept. 27, 1910. Date claimed under International Convention, Sept. 27, 1909.

In his specification, the patentee remarks: In the process of separating sulphuretted hydrogen from gases by passing it over an oxygen-yielding mass, it is known that bog-iron ore and analogous artificially prepared compounds of iron and oxygen act not only in a moist state, but also more or less efficiently when baked—*i.e.*, after the expulsion of the water. It has, however, been ascertained that the mass freed from water by heating—that is to say, the mass of iron oxide—only possesses adequate capability of reaction when maintained at red heat during the passing of the gases. This is a measure which is not compatible with the requirements of modern practice, in which copious production of bye-products is aimed at; the high temperature destroying several valuable products contained in the gases. Moreover, the maintenance at red heat is difficult to effect in the case of the masses used. In general, therefore, the practice has been to employ the purifying mass in a moist state, which allows of working at ordinary temperatures. If it does not originally contain organic matter, the mass, which may be Laming mass (sulphate of iron mixed with an excess of lime), or natural bog-iron ore, or Lux mass (bauxite residues containing soda), receives an addition of sawdust for loosening and moisture-retaining purposes. The absorbing capacity of such moist masses is, however, so slight that a large amount of space is required, with a very low rate of flow; and this involves considerable dimensions of the purifying apparatus—more particularly as regards ground area.

The present invention is based on the recognition of the fact that there is an intermediate stage of maximum absorbing capacity between the state of normal hydrated iron oxide, capable of acting as a purifier in a cold but moist condition, and the state of iron oxide obtained by expulsion of water from the hydrate, capable of acting in a dry state but only when heated; the intermediate stage being entirely free from moisture, with the reaction taking place at ordinary temperatures. This intermediate stage is represented by the modification of hydrated iron oxide, which is produced by gradual expulsion of the moisture and of part of the chemically combined water until the mass is neither hydrate nor oxide. The hydrated iron oxide undergoes several modifications sharply differentiated from each other by the colouring of the mass. The moist bog-iron ore heretofore used for the sulphur-purification is brown; but when wholly dried at about 95° or 100° C. the colour is changed to ochre. After partial expulsion of the chemically combined water, a dark red modification occurs, differing from the light red or yellow red of the oxide from which water has been wholly expelled. The dark red modification occurs after exposure for some time to temperatures varying approximately between 100° and 200° C. The period of exposure to produce this red modification varies according to the temperature employed—that is to say, the time required with a temperature of 100°, for example, is longer than with a temperature of 200°, for example, and *vice versâ*. The time is also dependent upon the quantity of water present in the mass—being longer for a large quantity of water than for a small. In fact, the time can only be fixed by experiment for each particular case. A higher temperature than 200° C. is not injurious if the period of exposure is correspondingly shortened. It is this red hydrate which possesses so high a capacity of absorbing sulphuretted hydrogen; the capacity being treble that of the moist hydrate, and the rate of absorption being very considerably increased.

The prepared hydrated iron oxide, obtained by carefully regulated heating of bog-iron ore or of similar artificially prepared mass, is preferably used in a granular state. If it is in the form of powder, agglomeration to a coarser granular state may be effected by means of a binding agent such as cement. By virtue of its nature and qualities, the prepared mass requires no loosening admixture; and in view of its dryness, there is no risk of caking and baking to a solid mass. The large active surface afforded by the fine distribution and porosity is not masked from the gas by water, and thus rendered partly ineffective. The rate of flow of the gas through the mass—hitherto usually 7 mm. per second—may be increased to 200 mm. per second; so that the excessive dimensions of the purifying plant are very greatly reduced.

Continuing, the patentee says: Inasmuch as the gases flowing through the purifying mass always contain water vapour, and as additional water is produced by the reaction binding the sulphuretted hydrogen $Fe_2O_3 + 3H_2S = Fe_2S_3 + 3H_2O$, there is some risk of deposition of water on the mass, liable on the one hand to chemically modify it, and, on the other hand, to obstruct the active surface. The water of condensation always contains admixtures, such as ammonia, separated from the gases. To allow of carrying out the process below 100° C., as is most advantageous, the gases are kept in a superheated state during their passage over the mass—that is to say, they are kept in a state in which they tend to absorb water. For this purpose the gases may be cooled before entering the purifier, and then re-heated, or they may be cooled as far as possible below the temperature at which the conversion is to take place in the purifier; and the restoration of heat is made by heating the purifier itself.

The regeneration of the mass may be effected in the simplest manner without removal from the purifier, by passing air or oxygen through it.

It has been found that if the processes described in patents Nos. 20,920 and 21,763 of 1908 are employed—that is to say, if the regeneration of the mass is carried on in such manner that the oxidation of the saturated mass extends to the formation of sulphur dioxide or sulphur trioxide - the great heat generated in the interior of the mass by the reaction (more particularly with rapid flow of air) readily produces temperatures up to bright red heat. The red hydrate is, of course, converted into iron oxide by separation of the residual chemically combined water; so that the mass becomes unsuitable for working in the manner described. This burning "dead" of the mass during regeneration can be prevented by arranging for the continuous, regular withdrawal of heat from the interior of the mass by arranging for the most favourable proportions of the cubical contents and surface of the purifying-box—that is to say, by using high, narrow boxes, or else cooling ribs or cooling pipes may be arranged to traverse the mass. In this manner, the chemical condition representing the final hydrate modification is preserved during the regenerating process, and the full absorbing capacity restored.

The sulphurous acid produced by the oxidation may be separately utilized—for example, for binding the ammonia in the gas. If the mass regenerated as described contains sulphate of iron, sulphite of iron, free acid, and ammonium sulphite and sulphate, and the like (due to the presence of ammonia in the gas), these substances must be separated in the course of regeneration, inasmuch as they greatly reduce the effective active area of the mass. It is, therefore, desirable to wash or lixiviate the mass—preferably with water, ammonia water, steam, and the like—and then dry it by reheating.

In itself, it appears immaterial, as regards the regeneration, whether the air current flows upwards, downwards, or transversely through the mass; but in practice it has been found that upward flow is to be preferred. In the case of downward flow, first adopted for simplicity, it was found that melted sulphur accumulated at the bottom of the purifier, and was thus withdrawn from the oxidizing process. This separation of free sulphur may be explained as follows: At the place where the air enters the purifying mass the oxidation of the sulphur is, of course, most energetic, by reason of the excess of oxygen still present. The zone of oxidation is gradually extended through the purifier, in the direction of the flow of air, accompanied by a corresponding increase of temperature. A zone of somewhat lower temperature advances in front of the oxidizing zone; this lower temperature being insufficient for complete oxidation, but capable of melting the sulphur in the mass. If the air is flowing downwards, the melted sulphur drips down and flows away; and this sulphur is very liable to obstruct the pipes. But if the air is flowing upwards, the melting zone is above the oxidizing zone; the melted sulphur trickles into the oxidizing zone, and is completely oxidized. This entirely obviates loss in cases in which the sulphurous acid from the purifier is utilized.

A special method of preparing the red ferric hydrate modification from natural bog-iron ore in the first instance consists in utilizing the peaty mass in the ore for continuously supplying the requisite heat; so that, after starting the process, the conversion continues by itself. A furnace is filled with pieces of bog-iron ore, and a small fire is made at the bottom. The peaty mass ignites, and the heat gradually spreads through the charge, expelling the moisture and then separating part of the chemically combined water. If, as in the case of the regenerating process described, care is taken to keep the temperature everywhere below bright red heat (by regulating the supply of air) the final product is the desired red ferric hydrate, which can be removed at the bottom, while a fresh charge is added at the top. The operation is thus entirely continuous.

Shoreham Harbour Coal Dues.—Shoreham Harbour dues are double as much on coal used for fuel as on that used for manufacturing purposes. It seems difficult to draw the dividing line. There was a discussion at a recent meeting of the Harbour Trustees over a requested reduction of dues on small coal. The Finance Committee reported against it, the "said coal not being considered as for manufacturing purposes." In the course of the discussion, it was remarked that the Brighton Corporation and the Gas Company both pay the higher dues, though in the one case the coal is used almost entirely for the manufacture of electricity and in the other of gas.

Artesian Wells in the City.—As readers of the "JOURNAL" are aware, the increase in the charges made by the Metropolitan Water Board has of late years resulted in the sinking of a large number of artesian wells in the City. Dr. Collingridge, the Medical Officer of Health, states that there are 36 such wells in existence, 14 of which were sunk between the 71 years 1836-1907, and the remaining 22, or 61 per cent. of the whole, in 1908 or 1909. According to the Public Analyst, the waters are highly pure, so far as organic contamination is concerned, and are soft, but somewhat saline. The adoption of a well water supply is gaining ground rapidly; great economy being claimed. But there is a possibility—undoubtedly remote—that the yield may eventually prove insufficient; and this would necessitate the reinstatement of the Water Board's supply, with the subsequent loss of the money spent in sinking the well.

Llanelly Council and the Gas Company.—As the result of an interview which Mr. Martin Richards, the Solicitor acting on behalf of the Llanelly Gas Company, had with the Roads Committee, the latter decided to recommend that, subject to the sanction of the Bench, the summonses taken out against the Company for failing to supply gas of proper quality be adjourned *sine die*. This recommendation came before the Council at their monthly meeting, and was agreed to. It was explained that the adjournment would be without prejudice to the rights of the Council, if necessary, to ask hereafter for the restoration of the summonses to the list. The Chairman said the Committee felt that, in view of the changes that had taken place in connection with the Company, they should hesitate before taking proceedings. The object of the Council had been gained, as a promise had been given by the Company that there would be no further cause of complaint. Subsequently an application was made to the Bench, who agreed to the proposed adjournment.

MISCELLANEOUS NEWS.

MANCHESTER CORPORATION GAS UNDERTAKING.

Annual Report.

We have received from the Superintendent of the City of Manchester Gas Department (Mr. F. A. Price) the report and accounts of the Gas Committee for the year ending March 31. The principal portions of the report, which bears the signature of Alderman R. Gibson, the Chairman of the Committee, are given below; some particulars from the accounts being held over till next week.

The quantity of coal and cannel carbonized (including the equivalent of enriching materials) was 498,709 tons, compared with 504,145 tons in the previous year; the quantity of gas made per ton being 11,349 cubic feet, against 11,034 cubic feet. The residual products made per ton of coal were: Coke, 13·72 cwt.; tar, 11·72 gallons; ammoniacal liquor, 29·20 gallons. The quantity of gas sent out from the works (5,663,570,000 cubic feet) shows an increase of 98,156,000 cubic feet, or 1·76 per cent., compared with a decrease of 73,037,000 cubic feet, or 1·29 per cent., the preceding year. The quantity of carburetted water gas produced during the year was 910,393,000 cubic feet, compared with 1,053,754,000 cubic feet the previous year. In the production of this gas 1,796,769,000 gallons of oil and 21,698 tons of coke were used, against 2,008,602 gallons and 23,754 tons respectively for the year ending March 31, 1910. The illuminating power of the gas sent from the works, as tested by the "Metropolitan" No. 2 burner, was 17·20 standard sperm candles. The unaccounted-for gas was 3·23 per cent., which compares with 3·34 per cent. for the previous year.

The number of consumers on March 31 was 181,356, of whom 10,663 were outside the city. The previous year the number was 178,490, of whom 10,431 were outside the city. The total increase was thus 2866. Of the total number of consumers, 63,663 use prepayment meters. This compares with 61,046 in the previous year—an increase of 2617; and of this increase, 2473 were fixed in the city and 144 in out-townships. The quantity of gas passed by these meters was 590,062,000 feet—an increase of 50,305,000 feet, or 9·32 per cent., on the previous year. The meters were inspected once every five weeks; and the amount collected during the year was £81,795. This is represented by 19,630,986 pennies, weighing 175 tons 5 cwt. 2 qrs. 3 lbs.

The number of gas-cookers owned and fixed by the Committee at March 31 was 53,730, compared with 49,948 for the year ending March, 1910. The total quantity of gas that was consumed by cookers is estimated at 695,000,000 cubic feet—being an increase of 39,000,000 feet, or 5·94 per cent., on last year's figures. There have also been fixed 30,831 grillers in connection with prepayment and small ordinary meters. About 46 per cent. of the consumers now have the free use of a cooker or griller. On March 31 last, the number of gas-engines in use was 1573, compared with 1613 in the previous year. The quantity of gas consumed by these engines was 380,994,000 cubic feet—an increase of 2,352,000 feet, or 0·62 per cent. The cost of coal, cannel, and oil per ton carbonized was 10s. 10·24d., against 10s. 10·16d. the previous year; while the receipts for residual products rose to 6s. 10·98d. per ton, compared with 5s. 7·90d., representing a saving of 1s. 3d. per ton in the net cost of raw material, which on the total carbonization of 498,709 tons amounts to £31,169.

The total income was £790,596, against £750,700; and the expenditure £600,475, against £582,808. The gross profit on the year's working was £190,120, out of which the sum of £46,236 was paid for interest on loans, &c. The net profit therefore amounted to £143,884, compared with £121,191 in the previous year. The details of its appropriation are as follows: Deficit for the year ended March 31, 1910, brought forward, £8403; to the sinking fund for redemptions of loans, £71,559; paid over to the city fund, £46,500; Cambridge Street depôt, £450; Lord Street depôt, £1512; general extensions, £5919; premiums, &c., on purchases of consolidated 4 per cent. stock for cancellation, £3537; reserve fund account, £6004.

In accordance with the resolution of the Council on the 3rd of May last, the price charged for gas used within the city for manufacturing purposes only will be reduced from 2s. 3d. to 2s. per 1000 cubic feet as from the 25th inst., provided the annual consumption is not less than 500,000 cubic feet. The quantity of gas supplied to prepayment meter consumers for 1d. will be increased from 30 to 33 cubic feet within the city, and from 25 to 28 cubic feet outside the city, as from the 30th of September.

During the year ended the 31st of March last, the No. 3 gasholder at the Gaythorn station was thoroughly overhauled and resheeted; and new offices were erected near the entrance gates for the accommodation of the principal foremen. At the Rochdale Road station, the "D" retort-house was remodelled and fitted up with a Fiddes-Aldridge stoking-machine; and a Telpher coke-conveyor takes the coke from the front of the retorts to a series of storage hoppers situated at the gable end of the retort-house. A range of coke-hoppers was also erected in the yard adjacent to the "B" retort-house. The improved coke-loading facilities at this station have been of great convenience to the customers. At the Bradford Road station, the new 10 million cubic feet gasholder, which has been described in the "JOURNAL," was commenced on April 15, 1910; and it will be ready for use before the end of the current financial year. The construction of the installation of vertical retorts at the Droylsden station was completed on the 13th of July, and the retorts brought into use; and it has been working very satisfactorily since that date. The Committee state that much valuable information has been gained with the coals tested in these retorts. The manufacture of sulphuric acid and sulphate of ammonia at the chemical works continues satisfactory. During the year considerable improvements were effected; the sulphate of ammonia house having been rebuilt, new fixed ammonia stills erected, and the plant generally rearranged. An installation of pumps has been erected alongside the canal in Lord Street, to deal with the pumping of oil and ammoniacal liquor from boats to the Bradford Road station.

The total length of mains now laid is 1,669,217 yards, or 948¼ miles

and 297 yards; being an increase of 10¾ miles and 185 yards during the year. This includes 1855 yards of high-pressure mains. The number of public lamps within the city is 20,357, and outside the city 1332—a total of 21,689. The incandescent system of lighting has been applied to all the lamps within the city; and the number of burners fixed thereto is 25,993. High-pressure lighting was installed in Piccadilly during the year; 22 lamps, each of 1500-candle power, having been fixed. This system of lighting is being extended to Mosley Street and St. Peter's Square.

HIGH-PRESSURE GAS LIGHTING AT SALFORD.

Proposed Scheme to Cost £2087.

The *agenda* for the meeting of the Salford Town Council last Wednesday contained a resolution of the Lighting Committee recommending the Council to adopt a scheme for the proposed lighting of Regent Road with high-pressure incandescent gas-lamps at an estimated cost of £2087, and to authorize the Committee to carry it out. When the minutes of the Committee were brought forward for confirmation, the Chairman (Alderman Hulton) said that, with the consent of the Council, he would withdraw the resolution for the present, as certain information had been given to him which he would rather lay before the Committee and have it discussed there than in the Council Chamber.

The withdrawal of the resolution was agreed to.

The report of the Committee states that the road named is at present lighted by 77 lamps, each containing three low-pressure incandescent burners, consuming 3½ cubic feet of gas per burner per hour, or a total consumption of 808½ cubic feet of gas per hour. These lamps, when all the burners are lighted, have a maximum illuminating power, in round figures, of 16,000 candles; and the cost per hour for gas at the present price—viz., 2s. 1d. per 1000 cubic feet—amounts to 1s. 8·212d. per hour. To these figures must be added the cost of mantles—giving a total cost for gas and mantles of 1s. 9·421d. per hour.

The existing system of lighting, though good as low-pressure systems go, is considered to be quite inadequate for the present requirements of so important a thoroughfare as Regent Road. The Committee have therefore adopted a scheme which provides for the fixing of 41 lamps, each containing two high-pressure inverted incandescent burners, having an illuminating power of 3000 candles, and consuming 50 cubic feet of gas per hour, or a total consumption for the 41 lamps of 2050 cubic feet of gas per hour, and a total illuminating power, when all the lamps are lighted, of 123,000 candles. The cost per hour for gas at the present time would be 4s. 3·25d. To these figures must, of course, be added the cost of flashlights (which would, however, only be burning during the periods the lamps were not lighted), the outlay for mantles, and the cost of electric current for driving the gas-compressor; making a total cost when all the lamps are lighted of 5s. 2·263d. per hour.

The cost of the necessary apparatus for the scheme is a sfollows: Two "D" size Keith rotary gas-compressors, &c., £260; foundations, &c., for them, £10; steel mains (2907 yards) laid on each side of the road, £1090; 41 service-pipes, £20; 41 steel lamp-columns, with ornamental cast-iron bases, fixed complete, £164; a like number of 3000-candle power lamps, £543—total, £2087. The cost for electric current per annum may seem rather high, the report adds; but it is explained that this figure would not be increased, even if the total number of 3000-candle power lamps were doubled. Consequently the cost for electricity per unit of light would come down very considerably as the work put upon the compressor approaches its total capacity.

NOTTINGHAM GAS AND WATER DEPARTMENTS.

At the Meeting of the Nottingham City Council on Monday last week, the reports of the Gas and Water Committees, which have already been noticed [*ante*, pp. 752, 761], were presented.

Mr. A. Ball, the Chairman of the Gas Committee, in moving the acceptance of their report, said the net profits for the past year were £47,142, compared with £54,016 in the corresponding period—a decrease of £6874. The causes of the decrease were not far to seek. In the first place, the increased assessment had cost the Committee £2589; the reductions in the price of gas supplied amounted to £8000 for the portion of the year during which they were in operation; the increase in the rate of wages came to £1600; and coal cost £3300 more—making total increases of £15,480. But for these items, the Committee would have made a profit of £8615 more than the previous year, because, owing to the greater efficiency of their retorts, they had been able to supply more gas. In the year 1901, the gas made per ton of coal carbonized was 9697 cubic feet, against 11,480 cubic feet in 1911—an increase of 1803 cubic feet. There was a rise of £10,540 in the receipts from residuals. The reserve fund was £144,000, and since the Corporation took over the undertaking many thousands of pounds had been paid over in relief of the rates.

Alderman F. R. Radford seconded the motion.

Mr. E. Richards congratulated the Chairman on the generally satisfactory nature of the report. He remarked that, as the Committee obtained better returns on the working of the undertaking, it would certainly reduce the number of men employed; and he thought they ought to see that their employees only worked six days per week, and received good wages. He advocated a reduction in the price of gas used for manufacturing purposes to (say) 1s. 10d. per 1000 cubic feet, at which figure there would, he said, be a profit of 14 per cent. They all wished to encourage new industries; but they also desired to benefit the industries they already had.

Mr. W. Hobson was of opinion that the ratepayers ought to receive direct benefit from the profits of the trading concerns, instead of these profits being raided as they now were by increased assessments for the relief of the rates.

Mr. Ball, in reply, said the Committee would take note of the suggestion made. As the report stated, the Committee had under serious consideration the question of the price of gas supplied for manufacturing purposes, and they hoped to be able to suggest some concession in the near future. But the Council must remember that the Committee had been making reductions each year; and if they were to go on doing this, and improving the lot of the workers, they would have a very difficult task to keep profits up to the present high standard.

The report was adopted.

Mr. A. R. Atkey, the Chairman of the Water Committee, in presenting their report, explained that, thanks to economies effected in working, the profits of the water undertaking in the past year were so increased that the annual cost of the Derwent Valley water scheme will probably be met without any increase in the water or general district rates, as was feared would be needed. The first payment towards the Derwent Valley scheme would become due next January, after which Nottingham's contribution would be from £20,000 to £25,000 per annum. For 1909-10, the profits of the Water Department were only £14,360—the highest on record up to then. Last year, however, economies and increased revenue had increased the profits to £21,122; and with a further natural development in this direction, there should be little difficulty in meeting the Derwent Valley obligations out of current income. As indicating the thoroughness with which the undertaking had been reorganized, Mr. Atkey mentioned that 7000 adjustments of assessments were made to get an increased income of £500. In other directions they had been in the position to reduce the cost of water to certain classes of consumers.

COCKERMOUTH GAS UNDERTAKING.

Advantages of Advertising.

The Manager and Secretary of the gas undertaking of the Cockermouth Urban District Council (Mr. Ernest D. Wootten) has presented his report for the year ended the 31st of March last. He says there was a considerable general improvement in the working results in the period named compared with the preceding year. The gross profit was £1269, against £1237; and the net profit was £274. Resulting from the policy adopted last year of holding an exhibition, and advertising cookers and fires in the local papers, there was a large increase of business. The market price of sulphate of ammonia had been considerably above the previous year's figures; and no doubt one of the influences of the increase was the propaganda work of the Sulphate of Ammonia Committee, to which body the Gas Department subscribed. Turning to the working results, these showed the undertaking to be progressive. The gas made, which was a stationary figure last year, showed an increase of 1,524,000 cubic feet, or 5·74 per cent.; and consequently the quantity of coal carbonized was increased—being 2714 tons, against 2554 tons. The yield per ton of coal was practically unchanged. A satisfactory amount of business was done in gas-fires; the increase in the number of users being 19. Taking into consideration the excellent condition of the finances, Mr. Wootten suggested the advisability of reducing the price of gas, which he said would tend further to popularize gas for heating and cooking purposes and produce an increased revenue which would be a set-off against the reduction. Mr. Wootten's report was embodied in that of the Gas Committee which came before the Council at their last monthly meeting. The Committee recommended that the price of gas to ordinary consumers should be reduced from 2s. 9d. to 2s. 6d. per 1000 cubic feet, the reduction to operate from the 1st of April last; and that the number of cubic feet of gas supplied for 1d. to prepayment consumers should be increased from 27 to 29 as soon as the meters could be altered.

In moving the adoption of the report, Mr. J. Fleming referred to the salient features of the year's working, and briefly reviewed the progress of the gas undertaking since it has been in the hands of the Local Board and the District Council. He showed how the price of gas had been reduced from 4s. 2d. per 1000 cubic feet to the figure now proposed, which, if adopted, would, he said, place the Cockermouth undertaking in the unique position of being the only one of its size in the country to supply gas as cheaply as 2s. 6d. per 1000 cubic feet; while of the Cumberland undertakings only three sold at a lower figure—viz., Carlisle, Workington, and Penrith. The works had been well maintained; and it was significant of their good condition that the Manager did not recommend any special expenditure. The policy of advertising had been demonstrated to be sound. The Institution of Gas Engineers were formulating a scheme for the national advertising of gas; and it was creditable that Mr. Wootten had already recommended a policy which was about to become part of a national programme. Mr. Stephenson remarked that when the gas-works were taken over by the town they were considered to be a "white elephant;" but no one could regard the undertaking in this spirit to-day. They had been fortunate in having a succession of good Managers; and they always seemed to have the happy knack of getting the best out of them. The report was adopted.

Suicide of a Gas Stoker.—On Monday last week, an inquest was held at Gainsborough in regard to the death of Thomas Haddon (32), a gas stoker employed by the Urban District Council. The man lived with his mother, a widow, who said that he came home at eleven o'clock on the previous Saturday morning and said he had to go on again at five o'clock. Shortly before that hour he sent her for a bottle of hop bitters, and when she returned he was lying with his throat cut. She said he had seemed upset about having to go to work again, as he was not very well. He had complained of late that his work was too much for him. His hours were from six in the morning until nine at night, and she had advised him to leave and get something else. Samuel Haddon, a brother, said deceased had complained about the work being too much for him, especially during the hot weather. A verdict of "Suicide while temporarily insane" was returned.

HOLBORN PUBLIC LIGHTING.

The Joint Proposal of the Gas and Electric Light Companies.

At the Meeting of the Holborn Borough Council last Wednesday—the Mayor (Mr. Horatio Porter, J P.) in the chair—the question of the lighting of the thoroughfares of the borough was again under consideration, upon reports presented by the Special Committee of the whole Council, to whom the matter had been referred, and the Finance Committee.

The question came up at the meeting of the Council on the 12th of April, when a joint tender for the lighting of the borough was received from the Gaslight and Coke Company and the Metropolitan Electric Supply Company, Limited [see *ante*, p. 184]. This tender was considered on the 24th of May by the Special Committee, whose report was submitted last Wednesday. It provided for an entire re-arrangement of the present system of lighting, so that approximately one-half of the area of the borough would be lighted by gas and the rest by electricity. The Companies named undertook, for the sum of £6950 per annum, to instal and maintain suitable lamps and fittings, and supply electric current or gas as necessary for giving a minimum light of 424,140 candles, distributed in accordance with a scheme included in the report. In High Holborn and New Oxford Street, there would be 18 electric and 20 gas lamps of 1800-candle power; while in Kingsway, High Holborn crossing, and Southampton Row to Vernon Place, there would be 2 electric and 26 gas lamps, and in Shaftesbury Avenue 21 gas-lamps, all of the above-named power. In High Holborn and New Oxford Street there would be 13 electric and 8 gas lamps, and in Tottenham Court Road 20 gas-lamps, all of 600-candle power. The remaining thoroughfares would be lighted by 400, 300, 180, and 90 candle power lamps. The totals were: Electric lamps, 966; gas-lamps, 879; total illuminating power, 424,140 candles. In the specification upon which tenders were invited, the total power required was 404,160 candles. But the Companies made certain suggestions which increased the total light. The Committee gave these particulars of the present cost of lighting and of the tenders received in July and January last:

	Cost Per Annum.	Candle Power.
Gas lighting, year 1909–10	£7102 ..	140,000
Gas Company's tender, July, 1910 . .	6688 ..	260,000
,, ,, ,, Jan., 1911 . .	7527 ..	405,000
Electricity Company's tender, do. . .	6602 ..	405,000

The Committee pointed out that the first tenders were not based upon a specification containing the terms and conditions of a contract such as it was necessary, in the interests of the Council, to insist upon. The joint tender was, however, made upon a specification prepared by the Borough Surveyor and approved by the Council. It provided for all new lamps and fittings, and contained conditions for the protection of the Council in all respects; and it was on the basis of a ten-years' contract, determinable at the end of the fifth year by the Council, on payment of £4400 by way of fine, or smaller sums in subsequent years. In a letter which accompanied the tender, the Companies stipulated, however, for the deletion of clauses 28 and 35 in the specification, otherwise the annual payment would, they said, be increased 10 per cent. Clause 28 provided for the imposition of fines upon the Companies in the event of the nominal candle power falling more than 10 per cent. on an average of 30 lamps taken on three succeeding nights; while clause 35 provided that they should adopt any subsequent improvement in burners, lamps, or appliances that might be made, without additional cost to the Council. As regarded the latter clause, the Committee thought the condition was too onerous, and might well be deleted without prejudice to the Council's interests; and they thought alterations in the schedule which had been made by the Companies with a view to bringing the lighting in certain streets into harmony with that of adjoining boroughs should also be agreed to. They were strongly of opinion, however, that the provisions of clause 28 were vital, and should be adhered to, as it depended entirely upon this clause whether the Council should retain any control over the efficiency of the lighting. Negotiations had taken place with the Companies on the point, but without any satisfactory result. The Committee expressed their concurrence in the opinion of the Works and General Purposes Committee that the new clause 28 proposed by the Companies was quite unacceptable, as not only did it allow of a normal reduction of no less than 20 per cent. in the candle power, but the penalty for exceeding this limit would be so trifling and difficult of enforcement as to be practically useless. They said they were unable to recommend any other than a general scheme of lighting for the whole borough; and they therefore saw no alternative but to accept the condition on which the Companies were willing to be bound by clause 28 as originally drawn—*i.e.*, by making an extra payment of 10 per cent. on the contract price, which would therefore be £7645 instead of £6950 per annum. The amount provided for lighting in the annual estimates was £7400, and a supplemental estimate for the difference between this amount and the contract amount had been submitted to the Finance Committee. The Special Committee concluded by recommending that the joint tender for lighting the streets of the borough for ten years for the sum of £7645 per annum, subject to the deletion of clause 35 in the specification, and the amendment of the schedule of lighting as proposed by them, should be accepted.

The Finance Committee, in the course of their report, pointed out that under the proposed contract the Council were purchasing on the deferred payment system a considerable amount of property. It was estimated that the sum to be thus spent was £11,000; but as about £2000 of this represented underground work which would be the property of the Companies, there remained £9000 for the above-ground property—viz., columns, lamps, lanterns, &c.—which would belong to the Council. As this amount was being paid over a period of ten years, it was clear that the Council were paying more than they would have to pay were they purchasing outright—that was to say, they were paying interest on the unpaid portion. The District Auditor, in his report for the year ended March 31 last, dealt with an analogous contract entered into by the Council, under which first cost and maintenance and interest were paid for over a period of years by equal instalments. He, in effect, considered that this system was equivalent to taking up a loan, and that consequently it required the sanction of the London County Council. The Committee were of opinion, therefore, that it would not be wise to enter upon the scheme proposed without protection being afforded to the members against surcharge of the amounts which represented interest. There were two alternatives which they put forward for the Council's consideration—one, that the sanction of the County Council should be first obtained to the form of contract; and the other, that negotiations should be entered into with the Companies with a view to the immediate purchase of the assets represented by the sum of £9000. If a contract were entered into from which this capital sum as a factor was eliminated, it need not be for more than a few years; thus rendering it unnecessary to bind the Council for so long a term as that proposed. The Committee therefore suggested that before the Council adopted the recommendation of the Special Committee with regard to the improved lighting of the borough, the words "subject to the consent of the London County Council being first obtained to the form and principle of the contract" should be added; or, in the alternative, that the recommendation be referred back to allow of negotiations with the Companies to ascertain the cost of purchasing the columns, lamps, &c., outright.

After some discussion, the recommendation of the Select Committee, together with the report of the Finance Committee, was referred to the Works Committee.

PLYMOUTH GAS COMPANY.

Reduction of Price—Co-Partnership—The Coalite Contract.

The Annual Meeting of the Plymouth and Stonehouse Gas Company was held last Thursday—Sir JOSEPH BELLAMY (the Chairman) presiding.

In their report, the Directors stated that, although an increased quantity of gas had been sold compared with the previous year, the receipts were less, owing to the reduction in the price of gas to 1s. 8d. per 1000 cubic feet, as from March, 1910. This price established a record for the Company. From the credit balance of profit and loss, amounting to £34,021, the Directors recommended the payment of a dividend for the half year at the rate of 6½ per cent. per annum on the ordinary stock, 10s. per share on the "additional" shares, and 9s. 6d. per share on the new shares, Act 1879—less income-tax. This would absorb £10,191; leaving £23,830 to be carried to the credit of the next account. Important renewals were being carried out in the manufacturing plant, which should help to improve the results, and consequently further strengthen the stability of the undertaking. The Company's mains were extended into the Plymstock district during last autumn. A large number of the inhabitants had already availed themselves of the Company's enterprise.

The CHAIRMAN, in moving the adoption of the report and balance-sheet, said the year's profit amounted to £31,644, as compared with £31,243 in the previous year; and as the reduction of 1d. in the price of gas meant a loss of £4000 in the revenue, this increase was satisfactory. Several shareholders had asked him how matters stood with regard to coalite, now that the plant was being taken down, and whether there was a profit or loss.

COALITE.

What was the history of their connection with the British Coalite Company? That Company, thinking Plymouth was a suitable place to make an experiment, approached the Gas Company and asked if they would give facilities for it. The matter was very carefully considered by the Directors; and he went to London, accompained by their Engineer, to meet the Directors of the Coalite Company and discuss terms with them. From the first he informed them—and they agreed with the view he took—that the Gas Company could not enter upon any speculation. They were quite willing to give the Coalite Company facilities to come down to Plymouth, and to supply the Gas Company with a certain quantity of gas at less than they could make it themselves; but the Directors absolutely determined that if any arrangement was entered into, they must have a profit on the transaction, whether the system was a failure or not. Among conditions which they laid down were the time within which the gas should be supplied to them; how the price was to be arrived at; and if by reason of the Coalite Company's inability to supply the gas the Gas Company had to go to the open market to buy coal, and the price was higher, the Coalite Company should pay the extra cost of the coal. They further stipulated that if the Coalite Company failed to carry out the contract, they should pay compensation, which was fixed at £1000. These terms were agreed to. From period to period the Coalite Company had to ask for an extension of time. They made some supplies of gas, but not the minimum fixed by the contract; and the Directors gave them additional time, but always maintained the original contract intact. But the time arrived when the Coalite Company were unable to carry out the contract. He was not going to discuss the reasons for the failure. Unfortunately, the plant was put there just after the winter supply of coal was finished; and the Company started with new plant in the summer, when nobody wanted coke or coalite. Plymouth was said to be unsuitable for the experiment; but he did not know any other town in the country that would be more suitable under the same circumstances. They remained good friends with the British Coalite Company right through; and he had no hesitation in saying that, though they had not got all the profit they might have had if the contract had been carried out as was intended, yet they had made a very good profit. Moreover, instead of the Coalite Company paying them £1000 in cash as compensation, they had taken over certain portions of the plant, which were useful to them. Some of the Directors of the British Coalite Company were personally known to him. They probably were misled by enthusiasts; but as to the honour of the Directors of the British Coalite Company, he was pleased to offer his testimony for what it was worth, and to say he had the utmost confidence in them.

NEW PLANT.

He went on to pay a tribute to the excellent work of the employees of the Company, and referred in particular to the success which had

attended the efforts to deal with the trouble from naphthalene. Six years ago they had as many as 20,000 cases of choked pipes in a year; but notwithstanding an increase of of 5000 in the number of consumers, there were last year only 1679 cases of the kind. This spoke volumes for the economical working of the undertaking. They had made very satisfactory contracts for a considerable period ahead. But they would have to do something further to compensate for the loss of profit which was brought about by the British Coalite Company ceasing to make gas for them. They had undertaken, therefore, to reconstruct the old No. 1 retort-house, put in an installation of Fiddes-Aldridge machinery for the simultaneous charging and discharging of the retorts, provide a complete system of conveyors and bunkers for coke, and instal Telpher plant in the coal-store. This new machinery would involve some expenditure of money; but it would increase the make of gas per ton, and lessen the cost of production. Having thoroughly investigated a new process of manufacture, and found it to be more economical, after allowing for the increase of capital expenditure, the only way to go ahead was to scrap their old plant and put in the new.

REDUCTION IN PRICE.

After making careful provision for the future, and having regard to the contracts they had made, and the new installation they were about to put in, the Directors had come to the conclusion that they might take a further step, and reduce the price of gas as from last March to 1s. 7d. per 1000 cubic feet for lighting and 1s. 4d. for power. These were remarkable figures for a Company so far distant from the coalfields. They at present allowed slot consumers a discount or return at the rate of 5d. per 1000 cubic feet; and the amount would be increased to 6d.

CO-PARTNERSHIP.

For the last two or three years the Directors had been desirous of doing something more to encourage the bulk of the people who worked for them; and they had decided to adopt the co-partnership system. It would apply to every employee earning weekly wages, except the clerical staff and the engineering staff. These staffs were not included because the members of the staffs were paid a bonus each year, subject to good conduct and work well performed. It was proposed to adopt 2s. as the standard price of gas. When gas was at 2s. per 1000 feet, there would be no co-partnership bonus paid to the men; but for each penny reduction from 2s. the men would be allowed 1 per cent. on the 52 weeks' wages of the year. With gas at 1s. 8d. per 1000 feet, this would give them 4 per cent. on the wages; and it was intended to start the scheme by making the bonus payable as from March 31 of last year. An account would be opened for each workman; and when the amount to his credit reached a sufficient sum to purchase £5 of the Company's stock, a body of trustees would invest the money in the stock for the man. Two accounts would be opened. One would be the co-partnership account and the other a sort of thrift or deposit fund account; and one-half of the bonus earned by the man for the 52 weeks would be credited to the co-partnership fund, and the other half paid to his deposit account. On the credit balances the Company would allow 4 per cent. interest. The deposit account was intended to be a little nest-egg for the thrifty man; and they, as other companies had done, would encourage thrift among the workmen by allowing them to deposit savings with the Company, at 4 per cent. interest. There would be trustees of the co-partnership fund and a Committee for the control of the deposit accounts; and the men would be represented on both. Some years ago they adopted an old age and invalidity scheme, which cost the Company at present about £400 a year. This they did not intend to interfere with at present. He hoped that, with the little extra push which the co-partnership scheme was calculated to stimulate, their ideal of bringing the price of gas down to 1s. 6d. per 1000 cubic feet might be realized.

The report was adopted, and the dividend recommended declared.

The retiring Directors were re-elected; and Mr. J. H. S. MAY, the Vice-Chairman and Senior Director, in acknowledging this, paid a tribute to the Chairman, who, he said, had a remarkable grasp of the business, and gave great attention to the interests of the Company.

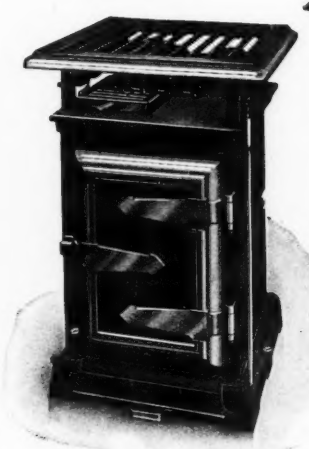
MALTA AND MEDITERRANEAN GAS COMPANY.

An Increased Balance in Spite of Competition.

The Ordinary General Meeting of the Company was held last Tuesday, at the London Offices, Nos. 59-60, Gracechurch Street, E.C.—Colonel JAMES LE GEYT DANIELL in the chair.

The SECRETARY (Mr. A. W. Cooper) read the notice convening the meeting and the report of the Auditors; and the report of the Directors and the statement of accounts were taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, said it would be within the memory of the shareholders that he spoke last year—and he believed also on one or two other previous occasions—of the effect that the naval establishment having installed their own electric light would have on the Company's business; and he further informed them that the military establishment had arranged with the Malta electric works for a supply for themselves. He further stated that he thought that, as the military establishments were generally speaking so much pinched for money, and so much under the Treasury, they might possibly have to turn to gas again from considerations of economy. The effect of the action of the naval establishment had been felt, as they would see from the present accounts; but to some extent this effect had been lessened by an increase from the military establishment, as he had conceived might perhaps turn out to be the case. This had relieved them somewhat. The shareholders would not, after what he had said—and taking into consideration also the keenness of the competition—be surprised to see from the accounts that last year's operations showed a decrease in gas-rental of £1143. On the other side, however, the coal used was 832 tons less. As a matter of fact, there was a saving over the previous year in coal, oil, and coke of some



THE "CORONATION" COOKER.

THE "MAIN" VALUE.

The ultimate and final success of anything depends upon its good value and upon its successful application to practical ends.

Your observation and knowledge guide you in the selection of the Cooker that is good value—

THE "MAIN."

Your consumers' practical experience with the Cooker endorses your judgment and reciprocates your guidance by recommendation.

RESULT, INCREASED OUTPUT.

R. & A. MAIN, LIMITED,

WORKS: Gothic Works, EDMONTON, N; and Gothic Ironworks, FALKIRK.
SHOW-ROOMS: 25, Princes St., Oxford Circus, W.; 136, Renfield St., GLASGOW; 56, Broad St., BIRMINGHAM 83, Old Market St, BRISTOL; 13, Whitworth St. West, MANCHESTER; 333, Queen St. MELBOURNE; and 12, Cunningham Lane, Pitt Street, SYDNEY.

£971; so that there was some slight compensation here. There were also savings in gas making of £104, and on maintenance of £330. All these matters enabled the profit and loss account this year to show a balance of £11,096, against £10,835 for the previous year. It would be seen from the general revenue account that the interest on the debentures was £398, as against £426 before. These were not large figures; but the difference was in consequence of them having paid off £2200 of debentures which matured during the course of the year. The Directors had also added £2000 to the amortizement account. This left an available balance of £6565, against £6084. There were one or two items in the accounts which might have struck the shareholders. The stock at stations was somewhat more; but this was not by any means an unhealthy sign, because the stock was comprised principally (if not entirely) of coal purchased at a convenient price for the Company. Another matter (which was referred to last year) was sundry debtors, under which heading the sum of £20,057 appeared on the present occasion. This was an item to which he desired again to draw attention. Twelve months ago, the amount was £19,245; so that this year there was an increase of £812. Now, the increase at Malta figured at £578, and at Marsala at £657. At Trapani, however, the item was some £550 less than was the case a year ago. The Sicilian stations had always occupied the attention—the very close attention—of the Board and of the Solicitors, and he was happy to be able to say also of the Foreign Office here, because they had put the Company into direct communication with the British Ambassador in Rome. The only thing the Ambassador could do, of course, was to urge what would be the Home Office in this country to take steps to impress upon the people concerned the necessity of paying their debts. A part of these debts, he would remind the shareholders, the Company had a judgment for; and for the remainder they were going to secure a judgment also. In fact, he had rather expected he would have been able to tell them at this meeting that the question had been decided. But instead of this, a telegram had arrived saying that the matter had been deferred by the Courts for another fortnight. His own opinion was that, as the people had always mentioned July as the month in which they expected to get money from the Government, they were putting the matter off until July arrived. The Board were, however, taking every precaution to protect the Company's interests. They were assured that they were perfectly safe, but that they must exercise patience. There was, however, a limit to everything—even to patience itself.

Mr. A. M. PADDON seconded the resolution.

Mr. H. R. SIBSON remarked that he thought it said a great deal for the Board and the management of the Company that, in face of the special difficulties which the undertaking had to contend against in the way of the competition of electricity and so forth, they were, after allowing for the additional amount brought in, able to show what was to him an agreeable surprise—an augmented balance on profit and loss account. He had been fully prepared for a slight set-back in the balance, in consequence of this persistent competition. Of course, the particular kind of competition referred to on the part of the electric light was not peculiar to the Malta and Mediterranean Gas Company In his own district they used to have an excellent system of public lighting by incandescent gas, which satisfied everybody except the Borough Council, who proceeded, at considerable expense, to substitute for it the electric light, which was by no means satisfactory. In fact, it demonstrated in a heavy fog which was experienced soon after it was installed, the singular lack of diffusive power of the electric light. Now the authorities had advertised for a man at about £200 a year to push electricity; and this seemed very unfair to the Company, who were, of course, very large ratepayers in the district. As he had remarked, it really did reflect great credit on the Directors and the management that, in face of such competition, they were able to show a larger balance. He would like to refer again to the heavy amount under the head of sundry debtors, which now reached the tremendous sum of £20,000—a very large percentage upon the capital. They knew the Board were doing their utmost, and that the matter might be safely left in their hands.

The CHAIRMAN replied that, with reference to the debt, the shareholders must look upon this principally as at Trapani and Marsala. The increase of £578 at Malta was purely temporary. Of course, they were supposed to be getting interest on the money which they had not been paid.

The motion was then put, and carried unanimously.

On the proposition of the CHAIRMAN, seconded by Mr. A. F. PHILLIPS, it was agreed that the usual dividends should be paid on the first and second preference capital and a dividend of 4 per cent., free of income-tax, on the ordinary capital, making, with the interim dividend paid last December, 6 per cent. for the year—leaving a balance of £1663 to be carried forward.

Proposed by the CHAIRMAN, and seconded by Mr. PHILLIPS, the retiring Director (Mr. Paddon) was re-elected; and the Auditors (Messrs. R. Hesketh Jones and Thomas Guyatt) were also re-appointed, on the motion of Mr. J. CASH, seconded by Mr. SIBSON.

Mr. PADDON, in proposing a vote of thanks to the officers in London and on the Mediterranean, remarked that the Company was abnormal in respect to the demands made upon the executive; and this fell with exceptional severity upon the executive officers at the seat of operations. The shareholders could easily understand, from what they had heard as to the debts, that the duties of their officers were by no means light. The best return they could make them was to tender them a very hearty vote of thanks for their services. Though this was a formal vote, the officers would miss it greatly if it were omitted; and they valued it very much if it was endorsed—as he was sure it would be—by the hearty good feeling of the shareholders.

Mr. E. L. BURTON seconded the vote, which was cordially passed, and suitably acknowledged by Mr. COOPER.

On the proposition of Mr. F. R. SMITH, seconded by Mr. SIBSON, a hearty vote of thanks was passed to the Chairman and Directors, and duly acknowledged by the CHAIRMAN.

The "WEE" Cooker.

JUIST the verra thing tae please the gude wife wha says she "haes na room for a Gas Cooker." Ye clap it on top o' the range an' there it'll dae it's wark while ye dae yer ain. The stand can be had tae if ye like, but it's no essential.

The "WEE" is supplied both Single-cased and Fully Packed, and lined with green enamelled steel plates. The vital component parts of each are identical and interchangeable.

Every essential so closely studied in connection with our larger cookers has been embodied in this small stove, so that it is equally conspicuous for

MAINTENANCE.

The Davis Gas Stove Co., Ltd., Luton.

MARKET HARBOROUGH GAS UNDERTAKING.

The Engineer, Manager, and Secretary of the gas undertaking of the Market Harborough Urban District Council (Mr. A. T. Harris) has presented his report for the year ended the 31st of March last, which shows that, as was briefly mentioned in our editorial columns last week, a profit of nearly £1000 was realized. The net receipts were £9650, or an increase of £556 compared with the preceding year; while the expenditure was £6624, or a rise of £234. The gross profit was £3026, which was £322 more than in the year 1909-10. The interest on loans and the repayment of principal came to £2093; and this deducted from the gross profit left a net surplus of £933. Coal cost £161 more than before, due to 100 tons extra being carbonized to meet the increased sale of gas, and also to slightly higher prices being paid. The make of gas per ton of coal was 12,150 cubic feet, against 11,800 cubic feet. The total make of gas was 55,892,000 cubic feet—an increase of 1,465,000 cubic feet; and the receipts from ordinary and prepayment meters were £4969 and £1781 respectively. The net total income from sales by consumers' meters was £6751—an increase of £299. The unaccounted-for gas was 5·64 per cent., against 5·41 per cent. the previous year. The numbers of ordinary and prepayment meters in use at the end of the financial year were 824 and 640 respectively—making a total of 1464; while the number of cookers in use, the property of the Gas Department, was 898. Referring, at the last meeting of the Council, to the results recorded in the report, Mr. Douglass said the past year had been the most successful since the Council acquired the gas-works. The profits were £103 more than any previous year, and £322 more than in 1909-10; while there was an increase in the make of gas of 350 cubic feet per ton of coal carbonized. The yield of sulphate of ammonia was higher than it had ever been before—mainly in consequence of improvements in the plant. Having dealt with other features of the year's working, the speaker concluded by tendering his personal tribute—and he thought all the members of the Council would join him—to Mr. Harris and his staff. He said he had seen a good deal of them during the past twelve months, and he considered the Council had a very excellent and conscientious body of servants, to whom great credit was due. Other appreciative remarks having been made in regard to the Manager, the report was approved, and Mr. Harris expressed his thanks.

Sidmouth District Council and the Gas Undertaking.—It may be remembered that the Sidmouth Urban District Council obtained the insertion of a purchase clause in the Bill promoted by the Sidmouth Gas Company. A special meeting of the Council was held last Tuesday to consider the subject; and it was decided to apply next session for a Bill to sanction the purchase of the Company's undertaking, which now includes the supply of electricity. The decision will be submitted to the ratepayers at a meeting on the 5th prox.

HOSPITAL LIGHTING QUESTION AT WELLINGTON (N.Z.).

Adoption of Electricity.

In the preceding volume of the "JOURNAL," several references were made to the subject of the lighting of the Hospital at Wellington (N.Z.). It may be remembered that the Gas Company's contract had expired; and though it was decided to renew it, this decision was rescinded in view of an exceptionally low offer made by the City Council to supply electricity. Thereupon a Committee of the Hospital Board recommended that the whole question should be reconsidered; and this was agreed to by the Board. From particulars contained in a copy of the "New Zealand Times" just to hand, we learn that the Board, on the recommendation of the Committee, decided to adopt electricity.

The Council offered to supply the Board at 3d. per unit, for so long as they chose to take the current for all their lighting; but if any reduction was made to the lighting consumers generally, one-fourth was to be allowed to the Board on the 3d. No such reduction was, however, to be made until the price of current to ordinary consumers for lighting purposes had been reduced below 6d. per unit. The price for current for other than lighting purposes would be 1½d. per unit, subject to revision if the Council lowered the present prices for power and heating to the general public. The Council's Electricity Department said they were prepared to supervise the fitting-up of the Board's buildings free of cost; and they estimated that 694 lamps could be installed (as against 523 gas-lights) for about £600—the estimated cost of maintenance being £35 per annum. If the Board desired, the Council were willing to find the capital required for the installation, to be repaid within two years, with interest at 5 per cent.

On the other hand, the Wellington Gas Company reported that their gas-pipes needed overhaul and rearrangement, and that to reduce the consumption and bring the installation up to date, new inverted burners and electric switches should be provided. The cost of this work was estimated to be about £300. If gas was to be continued even for heating purposes, the pipes must be examined to reduce waste. The Company offered to renew the contract at the present rate of 4s. 7d. per 1000 cubic feet, and still maintain the whole system for £50 per annum. With electrically operated switches, they maintained that gas presented all the convenience of electricity in its use.

The Committee considered the two offers from both a hygienic and a financial standpoint. They consulted the Medical Superintendent of the Board on the former question; and his decision was emphatically in favour of electricity. In order to determine the relative cost of gas and electricity as applied to a hospital ward, the Committee made several tests; and the conclusion arrived at was that the latter illuminant at the low price offered to the Board was not dearer than the former with modern burners, and would probably be 50 per cent. cheaper than the existing gas installation. As the rate of 3d. per unit quoted would apply to all the Board's institutions, the Committee

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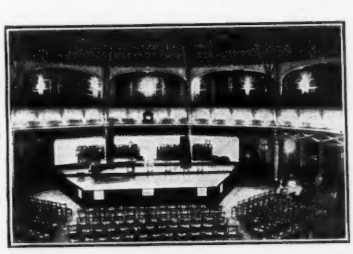

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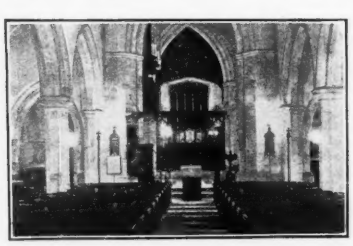
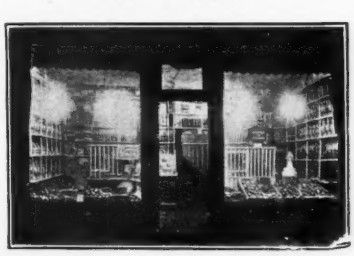
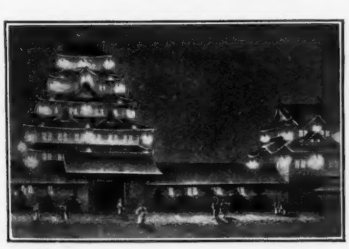


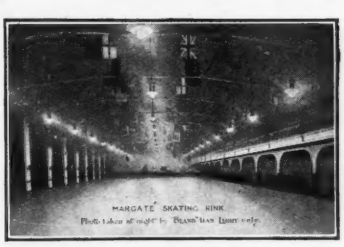
All Saints' Church, Leighton Buzzard.



Waddon's Stores, St. John s, Newfoundland.



Nagoya Castle, Japan.



Margate Skating Rink.

Grange Printing Works, Edinburgh.

The above Photographs were taken **AT NIGHT** by **BLAND** Gas **LIGHT** only.

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pointed out that there would be approximately a saving of £70 per annum in the cost of electric lighting of other buildings than those at the General Hospital; and this was an additional strong inducement for the acceptance of the Electricity Department's offer.

The Committee recommended as follows: (1) That the offer of the Electricity Department of the City Council be accepted, and that the Committee be empowered to arrange for the necessary lighting installation forthwith. (2) That the Committee be empowered to arrange terms for the continued use of gas for heating purposes, and, if they think fit, for any necessary overhaul of the gas-supply pipes and heating fittings. (3) That the Committee be empowered to consider and report upon the questions of heating water for ward use, and also the most economical heating of the Board's buildings.

These recommendations were embodied in a report submitted to the Board. Its adoption having been moved and seconded, Mr. Gardener protested against the Board adopting a system which meant in reality a policy of dishonesty on the part of the Corporation. There must be something at the bottom of the competition of the Corporation with the Gas Company. There was evidently something more than 3d. per unit at the back of it all. He submitted that people ought to know that electric light costing 5¾d. per unit was being supplied to the Board at 3d. Several members protested against Mr. Gardener making these remarks; and something like a scene ensued. Eventually, Mr. Fletcher said the City Council had taken up municipal trading, and had made an offer to the Board to do certain work as competitors with the Gas Company. The Council had made an offer as a business concern; and if the Board were satisfied that the work could be carried out satisfactorily and at a less cost than gas, it was their duty to adopt electricity. On a vote being taken, the report was adopted.

The above-named paper, commenting upon the subject, said: "The financial position is not made quite clear by the particulars disclosed. While it seems to have been fairly established that the lighting of the Hospital by electricity may come a little cheaper by purchasing electric current at 3d. per unit than by buying gas at 4s. 7d. per 1000 cubic feet, there will be the expense of installation, estimated at £600. Against this, it is shown that about £300 would need to be expended to overhaul the pipes and make other necessary alterations for the use of gas; while the annual cost of maintenance is put at £35 for electricity and £50 for gas. . . . It may seem a little odd, perhaps, that the Council is prepared to supply current to the Hospital at less than half the price charged to most of its customers; but that little puzzle—if it be one—need give members of the Board no anxiety. Their business is to do the best that is possible for the Hospital."

Extensions at Lytham Gas-Works.—The Gas Committee of the Lytham Urban District Council are about to erect a vertical water condenser of 500,000 cubic feet per day capacity, and to replace a single-lift gasholder by a three-lift spiral-guided holder 60 feet diameter, and having a capacity of 120,000 cubic feet. Messrs. Newton, Chambers, and Co., Limited, have obtained the contract for the work.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

In these northern latitudes we have this week been living in an atmosphere which can only be described as more celestial than that which we are accustomed to breathe. To have the foremost men in the gas industry gathered together in one place, as we had in the meetings of the Institution of Gas Engineers in Glasgow, and to listen while they described what they have found to be best, and prescribed what they conclude will be of the greatest advantage to the industry, is an experience encouraging and strengthening to those who are endeavouring in their solitary, and it may be small, spheres to work for the good of the common cause, and elevating to all who are of reflective mind. It was a great pleasure to see so many Scotch gas managers present, taking advantage of the privileges which accrue to them from affiliation. They must surely now be all convinced of the wisdom of the step which they took when they resolved to affiliate, and of the loss which would have been theirs if they had stood aloof from the main current of advance in gas supply. The meeting in Glasgow will be remembered, apart from its technical value, on account of the great unanimity and heartiness which characterized the whole of the proceedings connected with it—attributable in great measure to the happy manner in which Mr. Wilson conducted the business of the Chair; and it need not be left out of account that the lovely weather which characterized the whole week made the visit to Glasgow much more pleasurable than it might well have been. Visitors who saw Glasgow this week may have been led to form the opinion that smoke abatement is not so urgent a movement as it is generally represented to be; but such a conclusion, though excusable in the circumstances, would be an ill-founded one. There is much to be done in the direction of smoke abatement; and in this connection the new President—Mr. R. G. Shadbolt, of Grantham—did good work when, at the luncheon on Tuesday afternoon, he called attention to the large field which is open to the Corporation to occupy in the smoke abatement crusade, in the supply of the community with gas-cookers. Mr. Shadbolt's remarks may have the effect of stirring up some of the Councillors who are not yet sufficiently instructed upon smoke problems to be prepared to fall in with the wishes of the Gas Committee, and of Mr. Wilson, the Engineer, in the matter of the supply of gas cookers and fires. It is possible thus to foreshadow a benefit which the community may derive from the Institution meetings in Glasgow.

In the course of putting their house in order, after the gas transfer, the Town Council of Kirkcaldy have had to consider the question of who is to collect the revenues of the Gas Department. A section of the Council, with Treasurer Kilgour at their head, wish that the collection should be in the hands of the Burgh Chamberlain. There is opposed to them a party, led by Bailie Wright, the Convener of the Gas Committee, whose view is that the collection should be, as it has all along been, under the Company, in the hands of the Gas Engineer.

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LEST YE FORGET.

At the monthly meeting of the Town Council on Monday, the subject was discussed, with the aid of prepared reports on both sides, and the Council agreed that the collection remain as it has been for one year. The Council also had before them the question of the supply of gas to Thornton. The Engineer (Mr. J. Kincaid) reported that the scheme he considered the best would be to erect a steam-driven compressor, capable of passing 5000 cubic feet of gas per hour, at the gas-works, and to lay a 4-inch steel main to the west end of Thornton – a distance of 4½ miles. There the pressure would be reduced, and the gas distributed by 6-inch, 4-inch, and 3-inch steel mains throughout the village. He estimated the cost, exclusive of service-pipes, meters, and way-leave beyond the burgh boundaries, at £2570. Taking a low estimate, he would hope that in two years the annual consumption of gas in Thornton would be 2 million cubic feet, and soon afterwards 3½ millions. A charge of 1s. 6d. per 1000 cubic feet above the Kirkcaldy rate would yield £150; on 3½ million cubic feet, £219; on 4½ million cubic feet, £225; and on 6 millions, £250. It might be advisable, taking into consideration that there were competitors for the business, that the charges should be: Till 3½ million cubic feet annually were consumed, 1s. 6d. above the Kirkcaldy rate, then 1s. 3d. until 4½ million cubic feet were consumed, 1s. until 6 millions, 10d. until 8 millions, and after this 8d. per 1000 cubic feet. The present price of gas in Kirkcaldy was 3s. 2d., and 6d. extra to prepayment meter consumers, with discounts of from 5 to 17½ per cent. to large consumers. Mr. Kincaid's report was approved of, and it was resolved to proceed with the introduction of the town's gas into Thornton, provided that the terms be accepted by the representatives of Thornton.

On Thursday, a public inquiry was held in the Sheriff Court, Edinburgh, into the cause of the deaths of ten people who lost their lives through the fire in the Empire Theatre, Edinburgh, on the evening of May 19 last. Sheriff Maconochie presided. The stage manager stated that when the fire broke out there was a curtain roof over the stage, and below this roof there was a lantern hung, in which there were openings filled with gelatine, and in the inside seven coloured electric lamps. The lantern, another witness stated, was made of canvas. It was open at both ends, and a good current of air could pass through it. The first indication of fire was a flame which was observed running up the electric wire of the lantern. The electrician of the theatre, when asked his opinion as to the origin of the fire, assuming that it occurred in connection with the lantern, said the only thing he could think of was a faulty joint inside the lamp. Mr. Frank A. Newington, electrician to the Corporation of Edinburgh, considered that the fire might have been caused by the fusing of one or other of the wires in connection with the lantern. The Jury returned a verdict finding that the victims were suffocated in the fire; and they added a rider to the effect that in future the city authorities should exercise more scrupulous care, both with regard to the construction of theatres and the more frequent examination of electric lights and water hydrants. The question of fault was excluded from the purview of the Jury. While the cause of death has been certified to have been suffocation, the rider to the verdict saddles the responsibility for the fire which produced the suffocation upon electricity. One of the witnesses spoke to the probability of there having been a faulty joint; and the question of whether the lantern had received rough usage was also mooted. There could not have been, strictly speaking, a faulty joint, because the defect would have shown in the light—and the lantern had been in constant use, on that and other evenings, and had done its work efficiently. The hour of the day had doubtless more to do with the fire than anything else. The evidence was that the entertainment had just concluded, and the tableau curtain had been lowered. It is safe to assume that when this was done there would be a turning out of electric lights in the theatre—as there would be throughout the city generally at that late hour—and that a sudden flow of current had gone through the lantern, more than its slender, one-lamp wires could carry, with the result that one, or more, of them fused. Such a danger is present everywhere where electricity is used; and there is, so far as appears, no escape from the danger, unless by means of a cut-out fuse upon every lamp—which would be all but impracticable, and would certainly entail a cost which would be prohibitive of electricity for lighting.

Speaking at the annual meeting of Young's Paraffin Light and Mineral Oil Company in Glasgow on Monday, Sir James King said that the greatest loss the Company had sustained had been due to a heavy fall in the price of solid paraffin, which amounted to £53,500. The only outlet of magnitude for solid paraffin was in candles; and this was not an improving industry, owing to the keen competition of electric light, and of penny-in-the-slot gas-meters.

In the Arbroath Town Council on Monday, the Gas Committee reported that the Manager—Mr. A. C. Young—had brought to their notice that the amount of the suspense account at May, 1910, was £4865, and that there was a sum of £700 at the credit of the contingency and extraordinary damage account. As the Corporation were now insured against third-party risks, he thought the latter sum might be otherwise dealt with. The Committee recommended that the £700 be transferred to the suspense account, but that, at the same time, the insurance against third-party risks should be increased by one half, so as to make the indemnity £1500 in the case of any one accident, and £3000 in any one year of insurance. This was agreed to.

It is announced from Ardrossan that the policy of supplying gas-cookers free of charge, which was introduced by Mr. Jas. D. Keillor, the new Manager, has proved a great success. The appliances are given to all ratepayers who ask for them. About 500 have been taken up. As a result, the consumption of gas during May, it is reported, showed an increase of 228,000 cubic feet over that of May of last year.

At the annual meeting of the Inverurie Gaslight Company, a balance-sheet was submitted which was considered most satisfactory. It showed a revenue from the sale of gas amounting to £1380—an increase of £65. A dividend at the usual rate of 6½ per cent. was declared. This was the 72nd and final meeting of the old Company. The shareholders afterwards met as the new limited liability Company, and resolved to reduce the price of gas for lighting by 5d. per 1000 cubic feet. They

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also sanctioned several necessary works, which will cost a considerable sum, and which, it is reported, will enable the Company to provide a larger output of gas. In Inverurie, the Town Council are considering the question of a gas transfer. They met on Monday night, and, on the motion of Treasurer Rae, seconded by Provost Skinner, unanimously resolved to take steps to obtain a valuation of the plant and other effects belonging to the Company. The matter was remitted to a Committee, who will recommend a valuator for appointment.

In Monifieth the consumption of gas last year was 2 million cubic feet greater than in the previous year.

In the Denny Town Council on Tuesday, contracts were signed for the work involved in the extension of the gas supply to Dennyloanhead, Longcroft, Haggs, and Hollandbush. Twin compressors for the purpose, one to be driven by steam and the other by gas, and twin governors, with 4-inch bye-pass, will be supplied by Messrs. George Waller and Son, of Stroud. The provision to be made is for 400 houses. The estimated cost is £3200.

A very successful exhibition of gas cooking, heating, and lighting appliances was held in the Reid Hall, Forfar, last week. The exhibitors were Messrs. R. & A. Main, Limited; Messrs. John Wright and Co.; Messrs. Alder and Mackay; and Messrs. J. & W. B. Smith. At the opening ceremony, Provost Moffat stated that in Forfar they used to have a very small number of gas-cookers and gas appliances, but the number had been greatly increased. The hire charges made by the Corporation were from 4d. to 7d. per month. They were trying to give gas to their consumers as cheap as they possibly could, and at the same time make the gas-works pay. Mr. M'Dougall, who was Provost of Forfar about twenty years ago, said this was the third exhibition of gas cookers and heating appliances which he had seen in that hall; and it was the best that had yet been held. Since their last exhibition, there had been a great improvement in the manufacture of gas cooking and heating appliances. Mr. M'Dougall referred to the automatic gas lighting and extinguishing appliance of Messrs. Alder and Mackay, which was exhibited, and which he characterized as a great improvement upon the system of lighting and extinguishing the lamps in use. Mr. D. Morris, a representative of Messrs. John Wright and Co., recalled that in Forfar there was in use only one gas-cooker to every ten consumers of gas. In the course of the week, a baking competition among school girls was held, for which prizes were given. Lectures on cookery were given by Miss B. S. Robertson.

CURRENT SALES OF GAS PRODUCTS.

[For Table of "Tar Products Prices," see p. 943.]

LIVERPOOL, *June* 17.

Sulphate of Ammonia.

In the early part of the week trade in this article was of a desultory character, and the market continued to have a drooping tendency. During the last two or three days, however, there has been a general improvement in the demand, and some advance has been scored on the lowest point reached. At the close, the tone is very firm at £12 17s. 6d. to £12 18s. 9d. per ton f.o.b. Hull, £12 18s. 9d. to £13 per ton f.o.b. Liverpool, and £13 1s. 3d. to £13 2s. 6d. per ton f.o.b. Leith. There has also been a considerable amount of interest shown in future deliveries, and a fair number of transactions are reported by manufacturers for both July-December shipment this year and January-June next year at from £13 2s. 6d. to £13 5s. per ton f.o.b. at the principal ports.

Nitrate of Soda.

Some fresh arrivals of this article having now come forward, the position on spot is not so strong, and values have receded to 9s. 10½d. per cwt. for 95 per cent. and 10s. 1½d. for 96 per cent. quality.

LONDON, *June* 19.

Tar Products.

The markets for tar products have remained steady during the past week. There has been a little more inquiry for pitch, and in nearly all cases high prices are being quoted. Although steady, there is not so much inquiry in benzols. Solvent naphtha is quiet; but there is a fair demand for heavy naphtha. Creosote is steady, and a few transactions have taken place at to-day's values. Crude carbolic remains in about the same position.

The average values during the week were: Tar, 18s. to 22s., *ex* works. Pitch, London, 36s. 6d. to 37s.; east coast, 36s. to 36s. 6d.; west coast, Manchester, 35s. 6d. to 36s., Liverpool, 36s. to 36s. 6d., Clyde 36s. to 36s. 3d. Benzol, 90 per cent., casks included, London, 9d. to 9½d.; North, 9d.; 50-90 per cent., casks included, London, 8¾d. to 9¼d.; North, 8½d. to 9d. Toluol, casks included, London, 9¾d. to 10d.; North, 9½d. to 9¾d. Crude naphtha, in bulk, London, 4d. to 4¼d.; North, 3¾d. to 3½d.; solvent naphtha, casks included, London, 11d. to 11⅜d.; North, 10d. to 10½d.; heavy naphtha, casks included, London, 11½d. to 1s. 0¼d.; North, 10d. to 10½d. Creosote, in bulk, London, 2¼d. to 2⅜d.; North, 1⅞d. to 2d. Heavy oils, in bulk, 2⅜d. Carbolic acid, 60 per cent., casks included, east coast, 1s. 9d. to 1s. 9½d.; west coast, 1s. 8d. to 1s. 9d. Naphthalene, £4 10s. to £8 10s.; salts, 40s. to 42s. 6d., bags included. Anthracene, "A" quality, 1½d. to 2d. per unit, packages included and delivered.

Sulphate of Ammonia.

There has been considerable inquiry both for July-September and July-December delivery, which has had the effect of steadying the market. For the forward position, a considerable premium is quoted on the prompt prices; and to-day, actual Beckton is quoted at £12 12s. 6d. Outside London makes are £12 5s. to £12 7s. 6d. In Hull, £12 17s. 6d., and for July delivery £13 has been offered and refused. Liverpool, £12 17s. 6d., and for forward £13 5s. In Leith, nominally the value is £13 to £13 2s. 6d.; but for July-December delivery, £13 7s. 6d. is asked. Middlesbrough is £12 17s. 6d.

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COAL TRADE REPORTS.

Northern Coal Trade.

There has been heavy export of coals in the early part of the week, and the agitation in the shipping has not had much effect. With a full output, the quantity sent away has been enough to give some stocks for the heavy consumption that is expected at the Coronation rejoicings. In steam coals, best Northumbrians are from 10s. 6d. to 10s. 9d. per ton f.o.b. For second-class steams, from 9s. 3d. to 9s. 6d. per ton is quoted; and for steam smalls, from 5s. to 6s. 3d. In the gas coal trade, after great activity, there is a little ease. Durham gas coals vary in price. Best sorts are from 10s. 1½d. to 10s. 4d. per ton f.o.b.; seconds are near 9s. 6d.; and for "Wear" specials, from 10s. 9d. to 10s. 10½d. is quoted. No important contracts are reported; but offers are made for good gas coal for some of the ports of the Mediterranean, at prices which the coalowners deem inadequate for long-forward delivery. The higher prices that are quoted now are influenced by the proposed additional burdens on the industry, and these must be carried forward to the buyers. In the coke markets, there is quietness. Gas coke is now rather scarce, and for good makes from 14s. to 14s. 3d. per ton f.o.b. in the Tyne is quoted.

Scotch Coal Trade.

There is much complaint about the unsatisfactory position of trade. Orders can only be obtained at rates which leave small profit. The proposal has been made, and is being considered, that an agreement should be come to to restrict the output, by curtailing work in the pits to four days a week. The prices now quoted are: Ell, 8s. 6d. to 9s. 6d. per ton f.o.b. Glasgow; splint, 9s. 3d. to 9s. 6d.; and steam, 8s. 9d. to 9s. The shipments for the week amounted to 324,721 tons—an increase of 2750 tons upon the previous week, and of 13,594 tons upon the corresponding week last year. For the year to date, the total shipments have been 6,920,180 tons—a decrease upon the corresponding period of 23,159 tons.

Stafford Gas and Electricity Profits.—At the meeting of the Stafford Town Council last Tuesday, the Gas and Electricity Committee presented their annual report, already noticed in the "JOURNAL" (*ante*, p. 756). It showed that the gross profits of the gas-works were £14,172, and those of the electric lighting works £2734. After meeting the capital charges, there was an available balance on the gas-works account of £7710; and of this sum £3500 was transferred to the district fund in relief of the rates, £1250 to the suspense account relating to the installation of plant for making water gas, and £2000 was added to the reserve fund. The net profit on the electric lighting works was £607. In regard to the profit-sharing scheme, it was decided to pay a bonus of 10·56 per cent. on the wages to the men employed at the gas-works, and 10·4 per cent. to those engaged in the electric lighting works.

Heating Water by Gas.

One of the interesting and instructive lectures which Mr. Frederick Dye has been giving on the above-named subject, in different parts of the country, on behalf of Messrs. John Wright and Co., was delivered on Monday last week to the staff of the Tunbridge Wells Gas Company, under the presidency of Mr. Andrew Dougall, M.Inst.C.E., the Engineer and General Manager. About half of the lecturer's discourse was devoted to the subject of the practical fitting of domestic hot-water installations; and the rest to the possibilities of the gas-boiler and its applications. It was pointed out that with a well-designed gas-boiler water can be heated at less cost than with coal for short-period duties, each gallon of water at 145° (the hottest required for washing duties) being had with a consumption of 2¼ cubic feet of gas per gallon, or 15 gallons for 1d. Each gallon of water at 100° for baths is had with a consumption of 1¼ cubic feet of gas, or at a cost of a trifle less than 1d. per bath. At the conclusion of the lecture, a hearty vote of thanks was accorded to Mr. Dye, on the proposition of the Chairman, seconded by the Secretary of the Company (Mr. Charles F. Catt). The lecturer having briefly replied, questions were asked by the men, and fully answered. In addition to about sixty of the Company's staff, there were present employees from Tonbridge, Southborough, Sevenoaks, Crowborough, and East Grinstead.

Worcester's Unprofitable Electricity Undertaking.—There was a long discussion at last Tuesday's meeting of the Worcester City Council on the electricity undertaking. Mr. Clark, the Chairman of the Committee, having moved the adoption of the accounts, Mr. Fairbairn complained that an attempt was being made to make the Council and the public believe that all was going well with the undertaking. Alderman Millington said that the Corporation had no business to carry on the concern if they could get rid of it. He moved an amendment that the Committee investigate the statement as to the sale and purchase of the undertaking, and report to the Council. At present it was a bad egg. The amendment was lost, and the accounts were adopted.

Sale of Coke at Huddersfield.—In the course of the remarks made by Mr. E. A. Harman, the Gas Engineer and Manager of the Huddersfield Corporation, on Mr. Bernard F. Browne's paper at the meeting of the Institution of Gas Engineers last week, he alluded to the methods he adopts to dispose of his coke. He advertises in the local paper that the Gas Department will deliver coke in lots of 5 cwt. and upwards at varying prices according to the distance from the works. A quarter of a ton costs from 3s. 6d. for one mile up to 5s. 6d. for three miles; half a ton, from 6s. up to 8s.; and a ton, from 11s. up to 13s.—the rise in each case being 6d. for each half mile. As stated by Mr. Harman, prepared coke to mix with coal for domestic fuel is sold in paper bags, containing about 12 lbs., at 1d. each; quantities of six bags and upwards being delivered free.

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London Offices and Showrooms: 132, Queen Victoria Street, E.C.

General Offices and Works: Warrington.

Whitland Gas Company's Affairs.—It is stated by the "Llanelly and County Guardian" that there will shortly be heard in the King's Bench Division an important case, in which Mr. Vaughan Morgan, of London, sues the Water-Works, Lighting, and Power Investment Corporation, Limited, the Whitland and District Gas Company, Limited, D. J. Davies, I. Evans, H. J. Vivian, and Edmund Eaton. The plaintiff, who purchased 100 preference shares of £5 each in the Whitland Gas Company, seeks to have his name removed from the register of shareholders, and also claims £500 for alleged misrepresentation.

Bursting of a Water-Main in Islington.—Serious damage was caused by the bursting of a water-main on the night of the 11th inst. in Essex Road, Islington. The water tore up a portion of the roadway and flooded the surrounding houses, in some cases to a depth of 5 feet; the inmates barely having time to escape into the upper storeys. In a very few moments Essex Road was like a river. The conduits of the electric trams became chocked, and the cars were unable to proceed. The inhabitants of the neighbourhood became alarmed; and all that the police could do was to stop the traffic, and keep the people from going into dangerous positions. The Metropolitan Water Board have issued an official explanation of the accident. They state that the socket end of a 36-inch pipe burst, blowing out a piece about 2 ft. by 3 ft. The water found its way under the pavement and blew in the front of a shop in Essex Road, travelling through the basement, and making its way into the basements of about ten houses in Pickering Street, forcing out the party walls, and flooding each in turn; finally reaching the ground level and the street, and then getting away by the gulleys. The main was at once shut down, and within half-an-hour an emergency gang arrived and repairs were begun. The supply of water was carried on by other mains. The pipe, it is stated, was of excellent iron; and the probable cause of the burst was localized contraction owing to the change of temperature.

Southampton Water Supply.—At the meeting of the Southampton Town Council last week, the Town Clerk reported the receipt of a letter from the South Hants Water Company in reference to the provisional supply of water in bulk to the old borough. The Directors offered to sell to the Corporation water in bulk up to a maximum quantity of 500,000 gallons on any day of 24 hours, delivered at Otterbourne Hill into a main to be laid by the Corporation from the point of connection with the Company's main to the Corporation reservoir at Otterbourne, at the price of 6d. per 1000 gallons; the minimum quantity to be paid for quarterly by the Corporation to be 22,800,000 gallons. The Corporation are to bear the cost of connection to the Company's main, and provide the meter. An agreement is to be entered into for the supply to be furnished for a year, and so on from year to year, until determined by either party, with not less than three calendar months' previous notice in writing. On the Mayor's suggestion, the Council resolved to suspend the Standing Orders to allow of the letter being considered. His Worship also moved that it should be referred to the Council in Committee; and this course was adopted. When the business in public was resumed, the Mayor proposed that the question of the temporary supply of water to the Corporation should be referred to a Committee, to consist of the Parliamentary and Water Committees; and the proposition was agreed to with one dissentient.

Instow Water Supply.—An important development of the Barnstaple water undertaking was inaugurated yesterday week, when the supply to Instow was formally turned on. Instow is a place largely resorted to by visitors to the North Devon coast; and the problem of obtaining a water supply for it has been a matter of concern to the Local Authority for many years. The scheme now carried out has necessitated the laying of 8½ miles of mains by the Barnstaple Water Company, under an agreement with the Rural District Council, by which a minimum return on the capital outlay is guaranteed. Mr. C. E. R. Chanter, the Chairman of the Company, with several of the Directors, took part in the ceremony. There were also present the Engineer (Mr. C. N. Wood) and the Secretary (Mr. C. W. Parkin). In congratulating the inhabitants of the district on the fact that an abundant supply of water is now available, Mr. Chanter said the complete scheme included a service reservoir at Instow and a supply by ram to Worlington. The District Council, however, had not considered it necessary to construct the reservoir or put in the ram at present. The Company had an ample supply of water for all the district. Mr. G. C. Davie, Chairman of the District Council, turned on the water, and said that, while they had discussed many schemes, he had always been in favour of the one they had now carried out, a great advantage of which was that, as the number of consumers increased, the burden on the locality grew less, while under any other scheme the burden would have increased. He congratulated Mr. Chanter and the Engineer on the expeditious way in which the work had been carried out.

The gross profit of Messrs. Head, Wrightson, and Co. for the year ended April 30, amounted to £16,654, to which is added the balance of £2563 from 1910. The Directors propose to pay interest on the debentures for the year to the above-named date; to pay the dividend on the preference shares to March 31; to reserve for preference dividend from March 31 to April 30, £845; and to carry forward £1319.

The Consolidated Gas Purification and Chemical Company, of Nashville, Tennessee, of which Mr. A. S. B. Little is the General Manager, have sent us a booklet they have issued, bearing the title of "Purify the Safe Way." It is a collection of what are humourously called "Little Hints" on the subject of purification. They consist of extracts from papers and discussions, descriptions (with illustrations) of apparatus, &c.

In the "JOURNAL" for the 6th inst., reference was made to the fitting up with gas appliances of some of the houses at the Gildea Hall Estate, Romford. We learn that, in addition to the Company then mentioned, the Davis Gas-Stove Company have supplied a large number of goods to the estate, including their "New Davis" cooker in five different sizes, several gas fires and radiators, and a considerable quantity of utensils.

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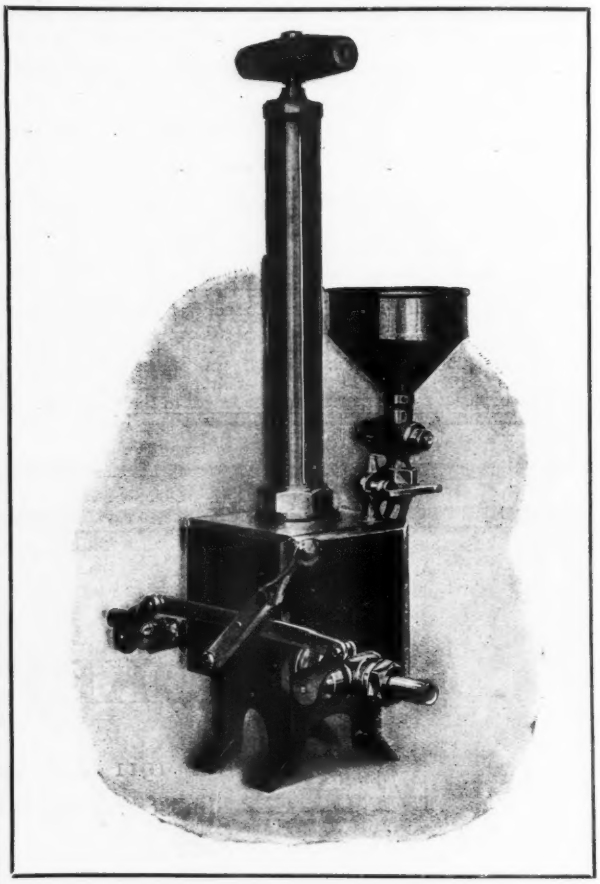

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The Richmond Gas Stove and Meter Company, Limited, have made arrangements to show their manufactures at the International Exhibition in Turin. One piece of the apparatus consists of three boilers of various capacities set in a cast-iron table with a boiling-table extended from it, having a variety of burners; also a large single oven with double doors forming part of the structure. The whole is arranged with all modern fittings. About fifty of this type have been put up in various institutions.

WANTED, FOR SALE, CONTRACTS, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Situations Vacant.

WORKING MANAGER. Woodhall Spa Gas and Water Company.
WATER ENGINEER. Southampton Corporation. Application by July 3.
REPRESENTATIVE (BURNERS AND MANTLES). No. 5417.
CLERK AND COLLECTOR. Bexhill Water and Gas Company.
DRAUGHTSMAN. No. 5418.
TAR-WORKS FOREMAN. No. 5415.

Plant, &c. (Second-Hand), For Sale.

METERS. Gaslight and Coke Company, London.
PURIFIERS, EXHAUSTERS, AND ENGINES, &c. Dumbarton Gas Corporation.

Plant, &c. (Second-Hand), Wanted.

WASHER, &c. No. 5416.

Stocks and Shares.

BRIGHTON AND HOVE GAS COMPANY. By Auction. July 4.
EAST GRINSTEAD GAS AND WATER COMPANY. July 11.
EAST HULL GAS COMPANY. By Tender. June 27.
GRAVESEND AND MILTON WATER COMPANY. July 11.
NORTH MIDDLESEX GAS COMPANY. By Auction. July 4.
REDHILL GAS COMPANY. July 11.
SOUTHEND WATER COMPANY. July 11.
SOUTHGATE GAS COMPANY. By Auction. July 4.
SUTTON GAS COMPANY. July 11.

TENDERS FOR

Coal and Cannel.

ALTRINCHAM GAS COMPANY. Tenders by July 8.
BAKEWELL URBAN DISTRICT COUNCIL. Tenders by June 30.

Coal and Cannel (*continued*)—

EAST RETFORD GAS DEPARTMENT. Tenders by June 30.
EVESHAM GAS DEPARTMENT. Tenders by July 1.
EXMOUTH GAS COMPANY. Tenders by June 30.
NEW MILLS URBAN DISTRICT COUNCIL. Tenders by June 19.
NEWRY GAS DEPARTMENT. Tenders by June 30.
NORMANTON GAS COMPANY. Tenders by June 23.
SEVENOAKS GAS COMPANY. Tenders by June 29.
SUNBURY GAS COMPANY. Tenders by June 29.
TEIGNMOUTH GAS DEPARTMENT. Tenders by July 3.
WAKEFIELD GASLIGHT COMPANY. Tenders by June 27.

Tar and Liquor.

BAKEWELL URBAN DISTRICT COUNCIL. Tenders by July 1.

TAR PRODUCTS PRICES.

Representative manufacturers give the following as fair current values for the week ending June 17. Prices are net, and they include the usual packages and delivery f.o.b., f.a.s., or f.o.r., as customary.

Article.	Basis.	London.	North-East Coast.	East Coast, Yorks.	West Coast.		Glasgow.
					Liverpool.	Manchester.	
Tar, crude	per ton	—	18/6 21/6	19/- 22/6	18/6 21/-	18/9 21/6	—
Pitch	,,	37/6	36/3	37/-	36/6	36/-	36/-
Benzol, 90%	per gallon	-/10	-/9	-/9	-/9¼	-/9	-/9¼
Benzol, 50-90%	,,	—	-/9⅜	-/9½	-/8¼	-/8⅜	—
Toluol, 90%	,,	-/10 -/10¼	-/9⅞	-/10	-/10	-/10	-/10
Crude naphtha, 30%	,,	—	-/3¾	-/4	-/3½	-/3½	—
Light oil, 50%	,,	—	-/3½	-/3⅜ -/4	-/3⅛	-/3⅛ -/3¼	—
Solvent naphtha, 90-160	,,	—	-/10	-/10	-/10	-/10 -/10¼	-/11
Heavy naphtha, 90-190	,,	—	-/11	-/11½	-/11¼	-/11¼	-/11
Creosote in bulk	,,	-/2½	-/2⅛	-/2	-/2⅛	-/2 1/16	-/1⅞
Heavy oils	,,	—	-/2½ -/2⅝	-/2¼	-/2⅜	-/2⅜	-/2⅜
Carbolic Acid, 60's	,,	—	1/9	1/10	1/7	1/7½	1/10
Naphthalene, crude drained salts	per ton	—	43/9	40/- 42/6	47/6	47/6 50/-	—
,, pressed	,,	—	60/-	63/-	60/-	60/- 72/6	—
,, whizzed	,,	—	—	—	70/- 72/6	60/- 75/-	60/-
Anthracene	per unit	-/2	-/1¼	-/1½	-/1¾	-/1¾	—

GAS COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 919.

Issue.	Share.	When ex. Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.	Issue.	Share.	When ex. Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.				£ s. d.	£			p.c.				£ s. d.
1,551,868	Stk.	Apl. 12	5	Alliance & Dublin Ord.	83—86	..	5 16 3	4,940,000	Stk.	May 12	9	Imperial Continental .	186—188	..	4 15 9
374,000	Stk.	Jan. 13	4	Do. 4 p.c. Deb.	95—97	..	4 2 6	1,235,000	Stk.	Feb. 10	3½	Do. 3½ p.c. Deb. Red.	92—94	..	3 14 6
200,000	5	May 12	7	Bombay, Ltd. . . .	6¼—6⅜	..	5 3 8	200,242	Stk.	Mar. 10	6	Lea Bridge Ord. 5 p.c. .	119—121	..	4 19 2
40,000	5	,,	7	Do. New, £4 paid .	5¼—5⅜	..	4 17 5	561,000	Stk.	Feb. 24	10	Liverpool United A. . .	214—216	..	4 12 7
50,000	10	Feb. 24	15	Bourne-) 10 p.c. .	28½—29½	+½	5 1 8	718,100	,,	,,	7	Do. B. . .	163—165	..	4 4 10
311,810	10	,,	7	mouth Gas) B 7 p.c. .	16⅜—16⅞	+⅛	4 3 0	306,083	,,	Dec. 30	4	Do. Deb. Stk.	102½—104½	..	3 16 7
75,000	10	,,	6	and Water) Pref. 6 p.c.	14½—15	..	4 0 0	75,000	5	June 15	6	Malta & Mediterranean	4⅜—4⅝*	..	6 3 1
380,000	Stk.	,,	12½	Brentford Consolidated	257—262	..	4 15 5	560,000	100	Apl. 1	5	Met. of) 5 p.c. Deb.	100—102	..	4 18 0
330,000	,,	,,	9½	Do. New . . .	203—208	..	4 11 4	250,000	100	,,	4½	Melbourne) 4½ p.c. Deb.	100—102	..	4 8 3
50,000	,,	,,	5	Do. 5 p.c. Pref. .	122—124	..	4 0 8	541,920	20	May 31	3½	Monte Video, Ltd. . .	12⅜—13½	..	5 5 8
206,250	,,	June 15	4	Do. 4 p.c. Deb.	97—99*	..	4 0 10	1,775,892	Stk.	Feb. 24	4½	Newc'tle&G'tesh'd Con.	102½—103½	—½	4 4 6
220,000	Stk.	Mar. 10	11	Brighton & Hove Orig.	217—220	..	5 0 0	529,705	Stk.	Dec. 30	3½	Do. 3½ p.c. Deb.	89—90	..	3 17 9
246,320	,,	,,	8	Do. A Ord. Stk. .	157—160	..	5 0 0	55,940	10	Mar. 10	7	North Middlesex 7 p.c.	15—16	..	4 7 6
490,000	20	Apl. 12	11¼	British	43¼—44½	..	5 5 7	300,000	Stk.	Apl. 27	8	Oriental, Ltd. . . .	137—139	..	5 15 1
120,000	Stk.	Dec. 30	4	Do. 4 p.c. Deb. Stk.	96—98	..	4 1 8	60,000	5	Apl. 12	8	Ottoman, Ltd. . . .	6⅞—7¼	..	5 10 4
109,000	,,	Feb. 10	6	Bromley, A 5 p.c. . .	116—118	..	5 1 8	31,800	53	Feb. 24	13	Portsea Island A . .	135—140	..	4 18 4
165,700	,,	,,	4½	Do. B 3½ p.c. . .	87—89	..	5 1 2	60,000	50	,,	13	Do. B . . .	—	..	—
82,278	,,	,,	5⅝	Do. C 5 p.c. . .	106—108	..	5 1 10	100,000	50	,,	12	Do. C . . .	120—125	..	4 16 0
55,000	,,	Dec. 30	3½	Do. 3½ p.c. Deb. .	84—86	..	4 1 5	114,800	50	,,	10	Do. D and E.	—	..	—
250,000	Stk.	,,	4	Buenos Ayres 4 p.c. Deb.	97—99	..	4 0 10	398,490	5	May 31	8	Primitiva Ord. . . .	7⅜—7⅝	..	5 3 3
100,000	10	—	—	Cape Town & Dis., Ltd.	3—4	..	—	796,980	5	Dec. 30	5	Do. 5 p.c. Pref. .	5¼—5⅜	..	4 8 11
100,000	10	—	—	Do. 4½ p.c. Pref. .	6—6½	..	—	488,900	100	June 1	4	Do. 4 p.c. Deb. .	97—99	..	4 0 10
50,000	50	Nov. 2	6	Do. 6 p.c. 1st Mort.	—	..	—	312,650	Stk.	Dec. 30	4	River Plate 4 p.c. Deb.	97—99	..	4 0 10
100,000	Stk.	Dec. 30	4½	Do. 4½ p.c. Deb. Stk.	88—90	..	5 0 0	250,000	10	Mar. 24	9	San Paulo, Ltd. . . .	20—21	..	4 5 9
157,150	Stk.	Feb. 24	5	Chester 5 p.c. Ord. . .	109—111	..	4 10 1	115,000	10	,,	6	Do. 6 p.c. Pref. .	12—12½	..	4 16 0
1,513,280	Stk.	,,	5⅝/9/4	Commercial 4 p.c. Stk.	114—116	..	4 14 3	125,000	50	Jan. 3	5	Do. 5 p.c. Deb. .	50—51	..	4 18 0
560,000	,,	,,	5⅜	Do. 3½ p.c. do..	108—110	..	4 16 11	135,000	Stk.	Mar. 24	10	Sheffield A	235—237	..	4 4 5
475,000	,,	June 15	3	Do. 3 p.c. Deb. Stk.	75½—77½*	..	3 17 5	209,984	,,	,,	10	Do. B	235—237	..	4 4 5
800,000	Stk.	May 31	4	Continental Union, Ltd.	92—95	—½	4 4 3	523,500	,,	,,	10	Do. C	234—236	..	4 4 9
200,000	,,	,,	7	Do. 7 p.c. Pref.	134—136	..	5 2 11	70,000	10	June 15	7	South African	8½—9⅛*	..	7 7 4
492,270	Stk.	—	5½	Derby Con. Stk. . . .	122—124	..	4 8 9	6,429,895	Stk.	Feb. 10	5/9/4	South Met., 4 p.c. Ord.	119—121	..	4 10 3
55,000	,,	—	4	Do. Deb. Stk. . . .	104—105	..	3 16 2	1,895,445	,,	Jan. 13	3	Do. 3 p.c. Deb.	80—82	..	3 13 2
148,995	,,	Apl. 12	5	East Hull 5 p.c. Ord. .	—	..	—	309,820	Stk.	Mar. 10	8	South Shields Con. Stk.	154—156	..	5 2 7
840,150	10	Jan. 27	10	European, Ltd. . . .	19—20	..	5 0 0	605,000	Stk.	Feb. 24	5⅜	S'th Suburb'n Ord. 5 p.c.	119—121	..	4 13 6
16,179,445	Stk.	Feb. 24	4⅜	Gas-) 4 p.c. Ord. . .	106—107	+½	4 7 2	60,000	,,	,,	5	Do. 5 p.c. Pref. .	118—120	..	4 3 4
2,600,000	,,	,,	3½	light) 3½ p.c. max. .	85—87	..	4 0 6	117,058	,,	Jan. 13	5	Do. 5 p.c. Deb. Stk.	123—125	..	4 0 0
4,062,235	,,	,,	4	and) 4 p.c. Con. Pref.	103—105	..	3 16 2	502,310	Stk.	May 12	5	Southampton Ord. . .	109—111	..	4 6 11
4,531,705	,,	June 15	3	Coke) 3 p.c. Con. Deb.	78¼—80⅝*	..	3 14 6	120,000	Stk.	Feb. 10	7	Tottenham) A 5 p.c. .	147—150	..	4 13 4
258,740	Stk.	Mar. 10	5	Hastings & St. L. 3½ p.c.	95—97	..	5 3 1	483,940	,,	,,	5½	and) B 3½ p.c. .	116½—118½	..	4 12 10
82,500	,,	,,	6½	Do. do. 5 p.c.	—	..	—	149,470	,,	June 15	4	Edmonton) 4 p.c. Deb.	96—98*	..	4 1 8
70,000	10	Apl. 27	11	Hongkong & China, Ltd.	17¼—17⅜	..	6 3 11	182,380	10	June 15	8	Tuscan, Ltd.	8⅜—9⅛*	..	8 13 0
131,000	Stk.	Mar. 10	7⅜	Ilford A and C . . .	147—150	+1	4 18 4	149,900	10	Jan. 3	5	Do. 5 p.c. Deb. Red.	98—100	..	5 0 0
65,780	,,	,,	5¼	Do. B	117—120	..	4 17 11	236,476	Stk.	Feb. 24	5	Tynemouth, 5 p.c. max.	115—117	..	4 5 6
65,500	,,	Dec. 30	4	Do. 4 p.c. Deb. . . .	96—98	..	4 1 8	255,636	Stk.	Feb. 24	6⅔	Wands-) B 3½ p.c. . .	141—143	..	4 14 5
								85,766	,,	Dec. 30	3	worth) 3 p.c. Deb. Stk.	73—75	..	4 5 6

Prices marked * are "Ex. div."

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GAS PLANT for Sale—We can always offer NEW and SECOND-HAND GAS APPARATUS, including Retorts and Fittings, Condensers, Exhausters, Scrubbers, Washers, Purifiers, Gasholders, Tanks, Valves, Connections, &c. Also a few COMPLETE WORKS. Compare Prices and Particulars before ordering elsewhere.
FIRTH BLAKELEY, SONS, AND COMPANY, LIMITED, Church Fenton, near LEEDS.

COAL TAR wanted.
BROTHERTON AND CO., LTD., Tar Distillers. Works: BIRMINGHAM, GLASGOW, LEEDS, LIVERPOOL, SUNDERLAND, AND WAKEFIELD.

SULPHURIC ACID — Specially prepared for Sulphate of AMMONIA and BENZOL Recovery Plants. JOHN NICHOLSON & SONS, LTD., Hunslet Chemical Works, LEEDS. Tele.: "NICHOLSON, LEEDS." Telephone: (Two lines), Nos. 2420 and 2421.

WANTED—Tar and Ammoniacal Liquor. Any Quantity.
GRINDLEY AND COMPANY, LIMITED, Rawcliffe, near Goole, YORKSHIRE.

PATENTS AND TRADE MARKS
PUBLICATIONS, "MERCHANDISE MARKS ACT, and Decisions thereunder," 1s.; "TRADE SECRETS v. PATENTS," 6d.; "DOCTRINE of EQUIVALENTS, Mechanical and Chemical," 6d. "SUBJECT-MATTER of PATENTS," 6d.
MEWBURN, ELLIS, & PRYOR, Chartered Patent Agents, 70 & 72, Chancery Lane, London, W.C. Telegrams: "Patent London." Telephone: No. 243 Holborn.

BROTHERTON & CO., LIMITED.
Offices: City Chambers, LEEDS.
Correspondence invited.

OXIDE OF IRON.
SPENT OXIDE PURCHASED.
BALE'S FIRE CEMENT.
PAINT FOR GAS-WORKS.
"KLEENOFF." THE COOKER CLEANER.

BALE & CHURCH,
5, CROOKED LANE, LONDON, E.C.

SULPHURIC ACID.

SPECIALLY prepared for the Manufacture of SULPHATE OF AMMONIA.
SPENCER CHAPMAN & MESSEL, LTD.,
with which is amalgamated WM. PEARCE & SONS, LTD., 80, Mark Lane, LONDON, E.C. Works: SILVERTOWN.
Telegrams: "HYDROCHLORIC, LONDON."
Telephone: 341 AVENUE.

AMMONIA Waste Liquor Disposal.
Purification Plant.
Results Guaranteed. No Working Costs.
JOHN RADCLIFFE, Chemical Engineer, EAST BARNET.

SULPHATE OF AMMONIA SATURATORS and all LEAD and TIMBER WORK in Connection with Sulphate Plants.
We guarantee promptness with efficiency for Repairs.
JOSEPH TAYLOR AND CO., CENTRAL PLUMBING WORKS, BOLTON.
Telegrams: "SATURATORS, BOLTON." Telephone 0848.

GAS OILS.

MEADE-KING, ROBINSON, & CO., Represent the Strongest Independent Refineries in America; also Petroleum Spirit for Gas Enrichment. 18, EXCHANGE STREET, MANCHESTER, and TOWER BUILDING, 22, WATER STREET, LIVERPOOL.

AMMONIACAL Liquor wanted.
CHANCE AND HUNT, LTD., Chemical Manufacturers, OLDBURY, WORCS.
Telegrams: "CHEMICALS."

"GAZINE" (Registered in England and Abroad). A radical Solvent and Preventative of Naphthalene Deposits, and for the Automatic Cleaning of Mains and Services.
It is also used for the enrichment of Gas.
Manufactured and supplied by C. BOURNE, West Moor Chemical Works, KILLINGWORTH, or through his Agent, F. J. NICOL, Pilgrim House, NEWCASTLE-ON-TYNE.
Telegrams: "DORIC," Newcastle-on-Tyne. National Telephone No. 2497.

FOR Instructions on Polishing and Cleaning Gas-Cookers and Gas-Fittings, read Canning Handbook on Polishing, Electro-Plating, and Lacquering. Fully illustrated. Price 2s. 3d., post free; abroad, 2s. 6d.
W. CANNING AND CO., BIRMINGHAM, and 18 to 20, St. John's Square, Clerkenwell, LONDON, E.C.

DISTRICT INSPECTOR.

THE Advertiser who invited Applications for the Post of DISTRICT INSPECTOR for a Town in the Midland Counties desires to THANK the several APPLICANTS for their Letters and to Notify them that the APPOINTMENT HAS NOW BEEN FILLED.

WANTED, a Foreman for Tar Works. Apply, by letter, to No. 5415, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WOODHALL SPA GAS AND WATER COMPANY.

THE above Company require a WORKING MANAGER for the New Gas-Works now being Erected.
Particulars may be obtained from, and Applications to be sent to, E. J. BROCKWAY, Gas Offices, CLEETHORPES.

WANTED, by Coke-Oven Firm, a good DRAUGHTSMAN. Situation suitable to Person accustomed to Gas Plant.
Apply, by letter, to No. 5418, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

ROBERT DEMPSTER & SONS, Ltd., Contractors for Complete CARBONIZING PLANTS and every description of GAS APPARATUS, ELEVATING, CONVEYING, and TELPHERAGE PLANTS, also STOKING MACHINERY, ROSE MOUNT IRON-WORKS, ELLAND.

COUNTY BOROUGH OF SOUTHAMPTON.

APPOINTMENT OF WATER-WORKS ENGINEER.

THE Corporation invite Applications for the Position of WATER-WORKS ENGINEER and MANAGER of their Water-Works, from properly qualified Engineers Experienced in the Design, Construction, and Maintenance of Water-Works.

The Gentleman appointed will be required to advise the Council upon all matters relating to the Water Supply of the Borough, to perform all the Duties devolving on him under the Public Health and Local Acts, to Devote his whole time to the Duties of the Office, and to engage in no other Business or Occupation.

He will hold office during the pleasure of the Council.

Salary, £300 per Annum.

Applications, stating Age, previous and present Occupation, Qualifications, and any other relative Particulars, accompanied by *copies* of not more than Three recent Testimonials, must be addressed to the Town Clerk, endorsed "Appointment of Water-Works Engineer" and delivered at the Town Clerk's Office before Twelve o'clock noon on the 3rd of July next.

Canvassing is prohibited, and will Disqualify.

R. R. LINTHORNE,
Town Clerk.

Town Clerk's Office,
Municipal Offices, Southampton,
June 14, 1911.

WANTED, by Leading House in In- candescent Burners and Mantles, an Up-to-date REPRESENTATIVE for Midlands and North of England. Must have live Connection. Good Salary to a Competent Man.

Apply, by letter, with *copies* of References, and stating Experience, to No. 5417, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, a Clerk and Collector with knowledge of Rentals.

Apply, stating Salary required and Experience, to the SECRETARY, Water and Gas Company, BEXHILL.

METERS.

THE Gaslight and Coke Company have FOR SALE a small stock of Second-Hand METERS, in Working Condition, at the following Prices—*viz.*:

Size.	Price Each.
100-Light	From £3 to £6.
150 "	" £5 to £8.
200 "	" £7 to £12.

A discount would be allowed where more than one is purchased.

The Meters can be Inspected, and all further particulars, obtained at 9, Laburnum Street, Kingsland Road, LONDON, N.E.

WANTED, a Second-Hand Washer for about 60,000 Cubic Feet per Twenty-four hours. Good condition.

Send full Particulars and Price to No. 5416, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

FOR SALE.—The Dumbarton Gas Cor- poration have FOR SALE One Set of Four PURIFIERS, 18 ft. by 10 ft., by 4 ft. 6 in. deep inside, 18-inch lutes, 12-inch Valves and Connections, and Lifting Apparatus.

Also One 30,000 Cubic Feet and One 14,000 Cubic Feet per hour EXHAUSTER, each with Steam Engine and 12-inch Connections and Valves.

Above being replaced by larger Plant.

Full Particulars may be obtained from the undersigned.

JOSEPH G. M'GEACHIN,
Manager.

THE Normanton Gas Company invite TENDERS for the Supply of 6000 Tons of GAS COAL to be delivered during the Year ending June 30, 1912.

Tenders for Screened and Unscreened Coal and Nuts to be sent in on or before the 23rd inst., addressed to the undersigned.

E. H. HUDSON,
Secretary and Manager.

TEIGNMOUTH URBAN DISTRICT COUNCIL.

THE Gas Department of the above Council invite TENDERS for the Supply of 4000 Tons of Best Durham or other good GAS COAL, (Screened or Unscreened). The same to be supplied to the requirements of the Council between the 31st day of July, 1911, and the 30th day of June, 1912.

The Coal must be Fresh Wrought and free from all Impurities.

No Special Tender Form will be issued.

Tenders must be accompanied by a full Description and Practical Working Analysis of the Coals quoted, and may be either f.o.b. at port of shipment, Teignmouth Harbour, f.o.r. Teignmouth Railway Station, or delivered into the Gas-Works Store.

Seaborne Coals must be carried in Sailing Vessels only.

Sealed Tenders, endorsed "Gas Coals," to be addressed to A. Percival Dell, Esq., Clerk to the Council, Town Hall, Teignmouth, and delivered not later than Monday, the 3rd day of July, 1911.

The Committee do not bind themselves to accept the lowest or any Tender.

By order,
J. ALEX. GRAY,
Gas Manager.

Gas-Works, Teignmouth,
June 15, 1911.

SUNBURY GAS CONSUMERS' COMPANY, LIMITED.

TENDERS FOR GAS COAL.

THE Directors of the above Company invite TENDERS for the Supply of about 2500 Tons of GAS COAL, for delivery between July 1, 1911, and June 30, 1912, or for 5000 Tons of Gas Coal to be delivered over Two Years, in such quantities as may be required by the Company's Manager. Prices to be stated for delivery, free of all Charges, either alongside a Riverside Wharf at Sunbury, or at Sunbury Railway Station.

Sealed Tenders, endorsed "Tender for Gas Coal," and accompanied by Practical Working Analyses, to be addressed to the Chairman of the Company, and delivered at the Company's Offices on or before the 29th inst.

All further Information required may be obtained on Application to Mr. S. Bark, the Company's Manager.

The Directors do not bind themselves to accept the lowest or any Tender.

By order,
J. W. WYNN,
Secretary.

June 3, 1911.

URBAN DISTRICT COUNCIL OF NEWRY.

TENDER FOR GAS COAL.

THE Gas Committee of the above Council invite TENDERS for the Supply and Delivery of about 3000 Tons of GAS COAL (Screened and Unscreened) for Twelve Months.

Specification and Form of Tender may be obtained on Application to Mr. B. Gibson, the Gas Manager.

Sealed Tenders, endorsed "Coal," to be forwarded to the Chairman of the Gas Committee, Town Hall, Newry, not later than Friday the 30th inst.

The lowest or any Tender not necessarily accepted.

WM. M. CRONIN,
Town Clerk.

Town Hall, Newry,
June 16, 1911.

NEW MILLS URBAN DISTRICT COUNCIL.

TENDERS FOR GAS COAL., &c.

THE New Mills Urban District Council invite TENDERS for the Supply of 3000 Tons of best GAS COAL and 500 Tons of CANNEL for the Year ending June 30, 1912.

Forms of Tender and full Particulars may be had on Application to the Gas Manager.

Tenders, properly endorsed, to be sent to me the undersigned so as to be in my hands not later than Four o'clock on Monday, June 19, 1911.

The Council do not bind themselves to accept the lowest or any Tender.

J. POLLITT,
Clerk.

Town Hall, New Mills,
June 8, 1911.

BOROUGH OF EVESHAM.

(GAS DEPARTMENT.)

TENDERS FOR GAS COAL.

THE Evesham Corporation invite TENDERS for the Supply of from 1000 to 3000 Tons (or less if required) of Best Screened GAS COAL during the year ending June 30, 1912, to be delivered on rail at Evesham.

Tenders, to be marked "Tender for Gas Coal," to be sent to me not later than the 1st day of July next, and to include full Description as to Coal and Price.

No form of Tender supplied.

The Corporation do not bind themselves to accept the lowest or any Tender.

THOS. A. COX.
Town Clerk.

Town Clerk's Offices,
Evesham, June 9, 1911.

BAKEWELL URBAN DISTRICT COUNCIL.

TENDERS are invited for the Supply of GAS COAL (1300 to 1500 Tons,) and 200 Tons of CANNEL for One Year delivered at Bakewell Station (Midland).

Forms of Tender and Particulars can be obtained from the undersigned, to whom Tenders must be sent by June 30.

Also for the Purchase of Surplus TAR and LIQUOR during the Twelve Months from July 1, next. Delivery free in Purchasers' Tanks at Bakewell Station (Midland).

Endorsed Tenders to reach the undersigned by June 30.

V. R. COCKERTON.
Clerk.

Bakewell, June, 1911.

EXMOUTH GAS COMPANY.

THE Directors of the Exmouth Gas Company invite TENDERS for the Supply of about 6000 Tons of Best GAS COAL (Screened or Unscreened), to be Delivered in such quantities and at such times as may be required from the 1st of August, 1911, to the 31st of August, 1912, and to weigh 20 cwt. to the Ton over the Gas Company's or Dock Company's weighbridge, the Coal to be Fresh Wrought, Dry, and free from Hards, Smudge, Shale, and Pyrites.

Tenders to be accompanied by Practical Working Analysis.

Prices may be quoted c.i.f. or f.o.b. (by sailing vessels only) Exmouth Docks, or f.o.r. Exmouth Railway Station (London and South-Western Railway).

Sealed Tenders, endorsed "Tender for Coal," to be sent to the undersigned not later than Friday, the 30th of June, 1911.

The Directors do not bind themselves to accept the lowest or any Tender.

Special Tender Forms are not provided or required.

JAMES T. FOSTER,
Secretary and Manager.

Gas-Works, Exmouth,
June 10, 1911.

TENDERS FOR GAS COALS.

THE Directors of the Wakefield Gas- light Company invite TENDERS for GAS COALS for the year commencing Sept. 1, 1911.

Forms of Tender and further Particulars can be obtained on Application to the undersigned, to whom Tenders, addressed to the Chairman and endorsed "Tender for Coals," must be sent on or before Tuesday, June 27, 1911.

H. TOWNSEND,
Engineer and Manager.

SEVENOAKS GAS COMPANY.

TENDERS FOR GAS COAL.

THE Directors of the Sevenoaks Gas Company invite TENDERS for 8000 Tons of GAS COAL (Durham or Yorkshire preferred), to be delivered at the Company's Siding (S.E. and C. Railway), Bat and Ball Station, Sevenoaks, for Twelve Months from July 1, 1911, to July 1, 1912.

Tenders must be sent in by not later than Thursday, the 29th day of June, 1911, addressed to the Chairman, W. Henry Cronk, Esq., 88, High Street, Sevenoaks, Kent.

Further Particulars may be obtained of the undersigned.

HENRY HOW,
Secretary.

Gas Offices, Sevenoaks,
Kent, June 15, 1911.

ALTRINCHAM GAS COMPANY.

COAL AND CANNEL CONTRACTS.

TENDERS are invited for Best Screened GAS COAL and CANNEL to be delivered free at Altrincham Railway Station as required for One or Two Years from July 1, 1911. The lowest Prices must be quoted, as no reduction of or rebate in such Prices will be expected.

Sealed Tenders, endorsed "Tender for Coal or Cannel," stating the Description of each, the Pits from which they are to be raised, the amount proposed to be supplied, and Cash Terms for Monthly Payments, to be sent, addressed to the undersigned, so as to be received not later than 12.30 p.m. on Saturday, the 8th day of July, 1911.

The Directors do not bind themselves to accept the lowest or any Tender; but the person or persons whose Tender may be accepted will be required to execute an Agreement for the due Performance thereof.

No special form of Tender is required or supplied.

F. R. B. LINDSELL,
Secretary.

Gas Offices, Moss Lane,
Altrincham, June 17, 1911.

BOROUGH OF EAST RETFORD.

TENDERS FOR GAS COAL.

THE Gas Committee of the above Corporation are prepared to receive TENDERS for the Supply and Delivery at the Sidings of the Great Northern or Great Central Railway Companies, Retford, of 8000 Tons of Best Screened GAS COAL or NUTS during the Year ending June 30, 1912.

The Coal must be freshly worked and free from Bats, Bind, or other Objectionable Matter.

Sealed Tenders, Specifying the quality of the Coal and the name of the Pit from which it is raised, to be sent in on or before June 30, 1911, addressed to the Chairman of the Gas Committee, endorsed "Tender for Gas Coal."

Forms of Tender and any further Particulars may be obtained from the undersigned.

J. B. FENWICK,
Engineer and Manager.

Gas and Water Office,
Retford, June 8, 1911.

EAST HULL GAS COMPANY.

SALE BY TENDER OF £25,000 FOUR PER CENT. DEBENTURE STOCK.

THE Directors Offer for Sale by TENDER the above amount of DEBENTURE STOCK to be issued under the provisions of the East Hull Gas Act, 1906, and the various Acts incorporated therewith.

Since the Year 1867, the Company has paid, without intermission, the Maximum Dividend allowed by Parliament.

The present issue of Debenture Stock will have priority against the Company and the Property from time to time of the Company, over all other claims on account of any debts, and will rank *pari passu* with that on all Mortgages or Debenture Stock at any time hereafter granted by the Company under its existing Acts of Parliament. Interest will be payable half-yearly by Warrants on the 1st of January and 1st of July in each year, in respect of the half years ending on the 31st of December and 30th of June immediately preceding.

Any amount of Debenture Stock being a multiple of £5, but not less than £20, may be applied for.

The Debenture Stock will be allotted to the Highest Tenders.

A Deposit of £10 per cent. on the nominal amount of the Debenture Stock applied for must accompany each Tender, and the allottees must pay the remainder of the Purchase Money on or before the 31st day of July, 1911.

Last Day for Receipt of Tenders, Tuesday, the 27th Day of June, 1911.

Forms of Tender and Particulars of Sale can be obtained at the Local Branches of Messrs. Barclay and Company, Limited, Bankers; or from the Offices of the Company.

By order of the Board of Directors.

DAVID WOOD,
Secretary.

Offices: St. Mark Street, Hull,
June 8, 1911.

SALES BY AUCTION OF GAS AND WATER STOCKS AND SHARES.

MESSRS. A. & W. RICHARDS beg to notify that their SALES BY AUCTION of NEW CAPITAL ISSUED UNDER PARLIAMENTARY POWERS, and of STOCKS and SHARES belonging to EXECUTORS and other PRIVATE OWNERS in LONDON, & SUBURBAN, and PROVINCIAL GAS and WATER COMPANIES, take place PERIODICALLY at the Mart, TOKENHOUSE YARD, E.C.

Terms for Issuing New Capital, and also for including other Gas and Water Stocks and Shares in these Periodical Sales, will be forwarded on Application to MESSRS. A. & W. RICHARDS, at 18, FINSBURY CIRCUS, E.C.

By order of Trustees.
GAS STOCKS AND SHARES
OF THE
CAPITAL VALUE OF UPWARDS OF £17,000.
IN THE
BRIGHTON AND HOVE GENERAL GAS COMPANY,
SOUTHGATE AND DISTRICT GAS COMPANY,
NORTH MIDDLESEX GAS COMPANY.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, July 4, at Two o'clock, in Lots.
Particulars of the AUCTIONEERS, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
SOUTHEND WATER-WORKS COMPANY.
NEW ISSUE OF £5000 FOUR PER CENT. PERPETUAL DEBENTURE STOCK,
AND
500 £10 NEW ORDINARY FIVE PER CENT. MAXIMUM SHARES.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, July 11, at Two o'clock, in Lots.
Particulars of the AUCTIONEERS, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
GRAVESEND AND MILTON WATER-WORKS COMPANY.
NEW ISSUE OF 500 £20 FOUR-AND-A-HALF PER CENT. PREFERENCE SHARES.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, July 11, at Two o'clock, in Lots.
Particulars of the AUCTIONEERS, as above.

By order of the Directors of the
SUTTON GAS COMPANY.
NEW ISSUE OF £6500 FOUR-AND-A-HALF PER CENT. MORTGAGE DEBENTURES.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, July 11, at Two o'clock, in Lots.
Particulars of the AUCTIONEERS, as above.

By order of the Executors of the late W. V. K. Stenning, Esq., and another Owner.
EAST GRINSTEAD GAS AND WATER COMPANY.
52 £10 "A" SHARES AND £316 "A" STOCK,
AND
94 £10 "B" AND "C" SHARES.
REDHILL GAS COMPANY.
54 £5 ORDINARY SHARES,
AND
£100 ORDINARY "B" STOCK.

MESSRS. A. & W. RICHARDS will SELL THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, July 11, at Two o'clock, in Lots.
Particulars of the AUCTIONEERS, as above.

MIRFIELD GAS COAL
UNEQUALLED.
Sperm Value 878·85 lbs. per ton.
Please apply for Price, Analyses, and Report to the
MIRFIELD COLLIERY COMPANY,
RAVENSTHORPE, near DEWSBURY.
LONDON: 16, Park Village East, N.W.

REALISTIC FOOD MODELS FOR GAS COOKERS.
(Suitable Sizes.)
As supplied to leading Gas Companies, &c.
FIGURES OF CHEFS, &c.
Apply GODFREY SUTCLIFFE,
Studio, Alexandria Hall,
WEST EALING, W.

TROTTER, HAINES, & CORBETT, LIMITED,
BRETTELL'S ESTATE,
FIRE-CLAY & BRICK WORKS,
STOURBRIDGE.
Manufacturers of GAS RETORTS, GLASSHOUSE FURNACE & BLAST-FURNACE BRICKS, LUMPS, TILES, and every description of FIRE-BRICKS.
Special Lumps, Tiles, and Bricks for Regenerative and Furnace Work.
SHIPMENTS PROMPTLY AND CAREFULLY EXECUTED.
LONDON OFFICE: E. C. BROWN & Co., LEADENHALL CHAMBERS, 4, ST. MARY AXE, E.C.

'BUFFALO' INJECTOR
Operated Entirely by One Handle.
Class A lifts 25 ft.
Class B lifts 12 ft.

SEND FOR LIST.
Telegrams: "Temperature London." Tel. No. 12,455 Central.
GREEN & BOULDING, LIMITED,
28, New Bridge St., LONDON, E.C.

KOPPERS' PATENT
CHAMBER OVENS.
Results obtained which have never been Surpassed by any other System of Carbonization.
Plants at Work and under Construction for the production of 18,000,000 cubic feet of Gas per Day.
See our large Advertisement appearing in alternate issues of the "JOURNAL."
The KOPPERS'
COKE OVEN AND BYE-PRODUCT CO.,
301, Glossop Road, SHEFFIELD.

JAMES OAKES & CO.,
ALFRETON IRON-WORKS, DERBYSHIRE,
AND
Wenlock Iron Wharf, 21 & 22, Wharf Road,
CITY ROAD, LONDON, N.
Manufacture and keep in Stock at their Works (also large Stock in London)
PIPES and CONNECTIONS, 1½ to 48 inches in diameter, and make and erect to order RETORTS, PURIFIERS and TANKS, with or without planed joints, COLUMNS, GIRDERS, SPECIAL CASTINGS, &c., required by Gas, Water, Railway, Telegraph, Chemical, Colliery, and other Companies.
NOTE.—Makers of HORSLEY SYPHONS. These are cast in one piece, without Chaplets; doing away with Bolts, Nuts, and Covers, and rendering Leakage impossible.

THOMAS TURTON AND SONS, LIMITED,
SHEAF WORKS, SHEFFIELD,
MANUFACTURERS OF
FILES OF BEST QUALITY
FOR ENGINEERS.
STEEL OF ALL DESCRIPTIONS.
SCREW STOCKS, TAPS AND DIES,
SPANNERS, RATCHET BRACES, LIFTING JACKS,
ANVILS, VICES,
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90, CANNON STREET, E.C.

BIRTLEY IRON COMPANY,
ESTABLISHED 1820,
Owners of the Birtley Iron Works and Pelaw Main Collieries,
GENERAL ENGINEERS & IRONFOUNDERS.
Makers of Cast-Iron PIPES and CONNECTIONS for Gas, Water, Steam, Electrical, Sanitary, and other purposes; also TANKS, COLUMNS of every description, Hydraulic, Gas, and Colliery PLANT, &c.
Illustrated Catalogue, giving complete list of our Manufacturers, on Application.
Works: BIRTLEY, CO. DURHAM.
Newcastle-on-Tyne Offices: MILBURN HOUSE.

Now Published. Price 1s. 6d. Post Free in the United Kingdom.
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AND
GAS LIGHTING.
By HENRY O'CONNOR, Assoc.M.Inst.C.E., &c.
A Course of Five Lectures Delivered before the Royal Scottish Society of Arts.
LONDON:
WALTER KING, 11, Bolt Court, FLEET STREET, E.C.

THOMAS DUXBURY & CO.
16, DEANSGATE, MANCHESTER,
Best Gas Coal and Cannel, giving High Illuminating Power, Large Yield per ton, and reasonable in Price.
Telegrams: "DARWINIAN, MANCHESTER."
Telephone 1806.

NEWBATTLE CANNEL.
Highest Results in Gas, & Excellent Coke.
QUOTATIONS ON APPLICATION TO
THE LOTHIAN COAL COMPANY,
— LIMITED, —
NEWBATTLE COLLIERIES,
NEWTONGRANGE, MIDLOTHIAN.

ALL the
BOYS CALORIMETERS
which have been in daily use in all the Official Testing-Stations in London for the last Five Years
WERE MADE BY
JOHN J. GRIFFIN & SONS,
— LIMITED —
KINGSWAY, LONDON, W.C.
Those desiring to obtain Gas Calorimeters as used in the Official Testing Places should see that the apparatus bears the name of the Original makers.
Descriptive Catalogue on Application.

HEATHCOTE GAS COAL
from the
Grassmoor Collieries
CHESTERFIELD.
Rich in Illuminating Power and Yield of Gas.
Above the Average in Weight and Quality of Coke.
Maintains a High Standard in Residuals.

SEND FOR 100 PAGE CATALOGUE OF:-
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THE LONDON ELECTRIC FIRM. CROYDON.
SUSPENSION DEVICES, WINCHES, PULLEYS, WIRE ROPE, ETC. ETC.

THOMAS BUGDEN & CO.,
India-Rubber and Airproof Manufacturers and General Contractors,
Telegrams: "AIRPROOF, LONDON." Telephone: 743 CITY.
116-118, GOSWELL ROAD, LONDON, E.C.
LARGEST MANUFACTURERS OF GAS MAIN BAGS.
Patentees of the DENMAR BAG.
Impervious to Main Liquor and Climatic Influences.
Oilskin Clothing, Diving and Wading Dresses, Sewer Boots, Tar Hose, Stokers' Mitts, Bellows, &c.
AS SUPPLIED TO H.M. GOVERNMENT.)
ESTIMATES GIVEN.

SIMMANCE-ABADY
PATENT
GAS CALORIMETER.
HUNDREDS IN USE.
MODERATE IN PRICE.
As verified by the National Physical Laboratory.
SOLE MAKERS:
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WESTMINSTER.

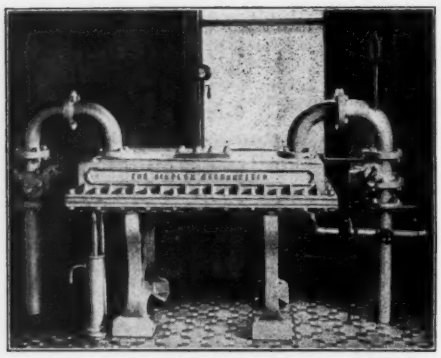
CLAYTON SON & CO
LIMITED
Pepper Rd. Branch, Hunslet, Leeds.

Interior View of Works Employed in the Manufacture of WELDED STEEL MAINS for WATERWORKS Etc.

"THE PARKINSON"
INVERTED
BURNER
LANTERN.

No. 163.
GAS AND AIR ADJUSTERS OPERATED OUTSIDE.
CAST BRASS BURNERS.
HIGHEST EFFICIENCY.
May we send you a Sample?
PARKINSON AND W. & B. COWAN Ltd.,
STREET LIGHTING SPECIALISTS,
Bell Barn Road, BIRMINGHAM.
LONDON. EDINBURGH. MANCHESTER
BELFAST. SYDNEY, N.S.W.

NAPHTHALINE AND ITS CURE.



THE "SIMPLEX" VAPORIZER.

THE "SIMPLEX" VAPORIZER.

This Apparatus is specially suitable for the prevention of Naphthaline deposits in the districts.
Fixed near the inlet or outlet of Gasholder, it can be used to vaporize a suitable Hydrocarbon into the Gas in such quantities as to entirely prevent the deposition of Naphthaline in the mains or consumers' services.
In operation at Hampton Court, Great Harwood, Clitheroe, Jersey, Kilmarnock, Hornsey, Gt. Yarmouth, Walton-on-Thames, &c.

PRICES AND FURTHER PARTICULARS CAN BE OBTAINED FROM

ROBERT DEMPSTER & SONS, LTD., ELLAND, YORKS.

TO GAS ENGINEERS

NAPHTHALENE SOLVENT.

Are you troubled with **NAPHTHALENE** in your **MAINS?** If so, try our special

"SOLVENE."

THE FINEST NAPHTHALENE SOLVENT.

ENQUIRIES SOLICITED.

BROTHERTON & Co., LTD.,

CITY CHAMBERS, LEEDS.

ARROL-FOULIS

Stoking Machinery

HYDRAULIC COKE PUSHERS

(HUNTER and BARNETT'S PATENT.)

WILL DISCHARGE A RETORT IN ONE OPERATION.

LARGE NUMBERS IN USE.

Full Particulars may be obtained from the Sole Makers,

SIR WILLIAM ARROL & CO., Limited,

GLASGOW.

LONDON ADDRESS: 56, VICTORIA STREET, S.W.

[See Illustrated Advertisement, June 13, p. 712.]

BUY OF THE MAKERS!

D. HULETT & CO., LTD.,

Gas Engineers,

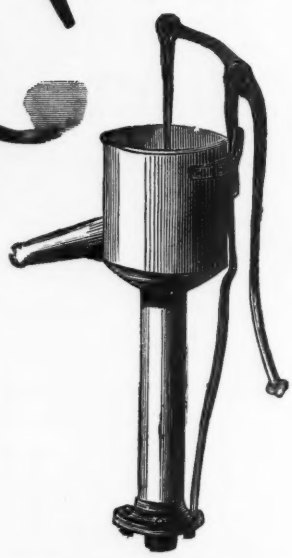
55 & 56, High Holborn, LONDON.

Our 'SPECIAL'

FORCE PUMP

For Small Services.

"Light, but Powerful."



Our 'No. 49'

GALVANIZED

IRON PUMP

With 2½ in. Solid Drawn Barrel and Wrought-Iron Handle.

This Pattern is also made "All Copper."

SEND FOR LISTS.

CAST-IRON PIPES FOR GAS, WATER, & STEAM,

also VALVES of all descriptions.

R. LAIDLAW & SON, LTD.,

ALLIANCE FOUNDRY, 147, MILTON STREET, GLASGOW,
And LAMBHILL FOUNDRY, GLASGOW.
OFFICE: 147, MILTON STREET, GLASGOW.

Now is the time to fit your Hydraulic Mains with "MEUNIER'S" PATENT FLOATS, and secure largely increased makes per ton.

SOLE AGENTS— **ROBERT DEMPSTER & SONS, LTD., ELLAND.**

ADOPTED AT—

ALTRINCHAM
ALTRINCHAM (Repeat Order)
BARKING
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PINTSCH SPECIALITIES:

INDOOR BURNERS

IN ENAMEL, POLISHED BRASS, OR OXIDIZED COPPER.

OUTSIDE LAMPS

WITH LEVER TAP AND BYE-PASS.

THE BEST BURNER FOR FACTORY USE.

WORKSHOP BURNER
(NO GLASS REQUIRED.)

PRICES ON APPLICATION.

PINTSCH COMPRESSORS.

ALL SIZES FROM 150 TO 20,000 CUBIC FEET CAPACITY.

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LONDON SALES DEPT: 15, FARRINGDON AVENUE, E.C.
MIDLAND SALES DEPOT: 82, UPPER PARLIAMENT STREET, NOTTINGHAM.

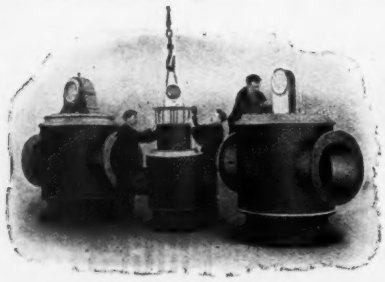
BEST & LLOYD, LTD.,
BIRMINGHAM.

BEST'S TRADE MARK. SURPRISE.

SPECIAL NOTICE.

See that every Pendant bears our Trade Mark (as above) stamped upon the balance weights!!!

MAKERS OF THE PATENT
"SURPRISE"
GAS PENDANT.



OVER 600
ROTARY
Station Meters
IN COMMISSION.

Particulars from—
T. G. MARSH,
28, Deansgate,
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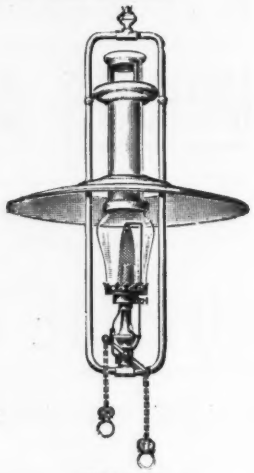
THE STEADY SALE OF THE
LUCAS
Self-Intensive High-Power Lamp
Is the Best Proof of its Usefulness.

OUTDOOR.



INDOOR.

ABSOLUTELY WIND, DUST, AND INSECT PROOF.
200, 400, and 700-Candle Power from a Single Mantle,
with Gas at its usual Pressure, and Lowest consumption on record.

MOFFAT'S LTD.,
13, FARRINGDON ROAD, LONDON, E.C.
Telephone: No. 1848 Holborn. A.B.C. Codes, 4th and 5th Editions,
Telegrams: "Monadnock, London." also Western Union.

ASHMORE, BENSON, PEASE, & CO., LTD.,
STOCKTON-ON-TEES,
Wish to draw Engineers' attention to the following:

ROTARY WASHER SCRUBBER,
Patent No. 4513, 1910.

The Important Features of their **NEW WASHER-SCRUBBER** are the Washing Bundles are constructed of

NON-METALLIC and NON-CORROSIVE Material.

EXTERNAL and ACCESSIBLE Liquor Overflows.

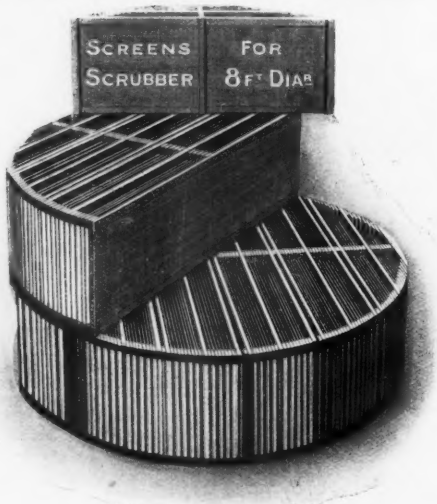
GREAT REDUCTION OF BACK PRESSURE.

SAFEGUARD AGAINST CORROSION AND CONSEQUENT ACCIDENTS.

EXISTING Washer-Scrubbers can be **RE-FILLED** with this Patent Non-Corrosive Filling, which would result in an **INCREASE OF CAPACITY.**

Washer-Scrubbers upon this system can be seen working and Inspected upon Application.

CANVAS SCREENS for TOWER SCRUBBERS.



Engineers requiring **ADDITIONAL SCRUBBING AREA** can **INCREASE** their **EXISTING** Apparatus
50 per cent.
by substituting **CANVAS SCREENS** for wood or any other type of filling.

GRAETZIN LIGHT.

MOST IMPORTANT!

Latest Development:

600 C.P. LOW PRESSURE LAMP.

1000 C.P. LOW PRESSURE LAMP.

GAS REGULATION on the TOP of the LAMP.

All Goods are unapproachable for economy and durability.
Ask Wholesalers for Catalogue and Prices.

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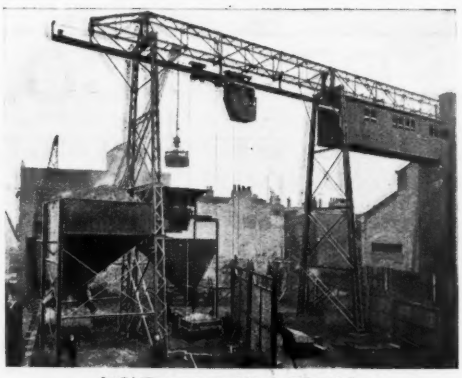
COMPLETE COAL HANDLING PLANTS.



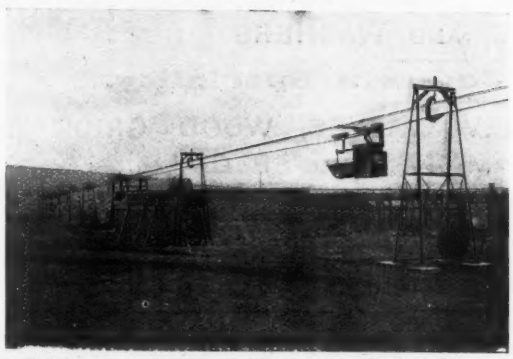
[50] Tons per Hour Plant.

25 Tons per Hour Plant.

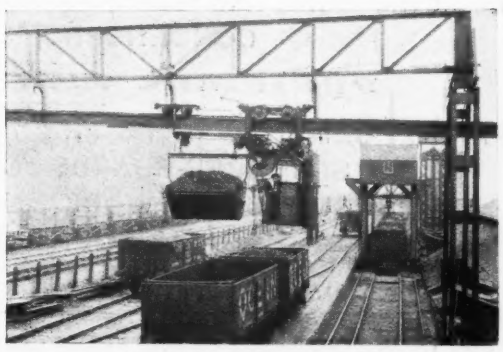
Any Capacity. Highest Efficiency. Low Working Cost.

We invite inspection of our Plants.

Full Particulars on application



Telpher running on Cable Track. 30 Cwt. load.



Telpher. 20 Cwt. load.

JOHN BROWN & CO., LTD., SHEFFIELD,

Proprietors of

ALDWARKE MAIN, CAR HOUSE, & ROTHERHAM MAIN COLLIERIES, NEAR ROTHERHAM.

ALDWARKE MAIN GAS COAL

Analysis: 12,600 Feet of 19-Candle Gas per Ton.

Value in Pounds of Sperm, 820·20.

VERY FREE FROM IMPURITIES.

TELEGRAMS: "ATLAS, SHEFFIELD."

COAL TAR PRODUCTS.

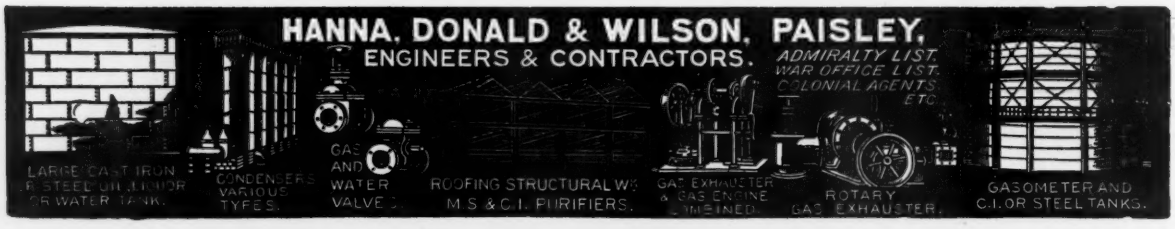
Benzol, Toluol, Solvent Naphtha, Creosote Oils, Grease Oils, Carbolic Acid, Dark Cresylic Acid, Granulated (Crude) and Sublimed Naphthalene, Anthracene, Refined Tar and Pitch. Sulphate of Ammonia containing a Guaranteed Minimum of 25 per cent. Ammonia.

For Prices apply to the **SOUTH METROPOLITAN GAS COMPANY,**

Works: ORDNANCE WHARF, EAST GREENWICH, LONDON, S.E.

709, OLD KENT ROAD, LONDON, S.E.

Telegraphic Address: "METROGAS, LONDON."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LARGE CAST IRON & STEEL GAS LIQUOR OR WATER TANK.
CONDENSERS VARIOUS TYPES.
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GAS EXHAUSTER & GAS ENGINE COMBINED.
ROTARY GAS EXHAUSTER.
GASOMETER AND C.I. OR STEEL TANKS.

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IMPROVED COAL AND COKE HANDLING PLANT, CONVEYORS, AND ELEVATORS.
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PURIFIERS with Planed Joints a Speciality.

PATENT CENTRE-VALVES, RACK AND SCREW VALVES, WOOD GRIDS AND SCRUBBER-BOARDS, CAST-IRON MAINS, AND SPECIALS.
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GASHOLDERS, CAST-IRON OR STEEL TANKS.

DESIGNS, SPECIFICATIONS, and ESTIMATES FREE.

PIG IRON (special quality) for Engine Cylinders. GAS COAL famous for its Unrivalled excellence.

Established 1793.

JOHN HARPER & Co., Ltd.,

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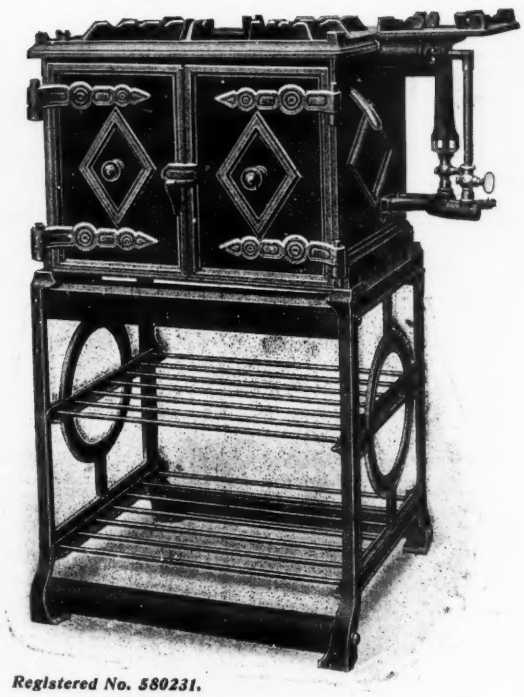
Telephones: 12, DARLASTON (2 lines),
8023, LONDON WALL.

London: 4, NEW UNION STREET,
MOORFIELDS, LONDON, E.C.

GRILLERS.

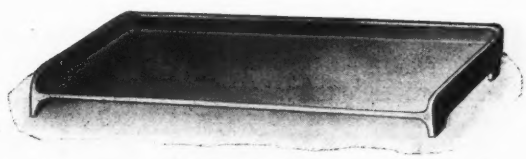


Registered No. 580231.

Registered No. 581284.

Griller.

Height: 7¼-in. Width: 12¾-in. Depth: 9-in



Hero Tray.

Tray ... ... 13½ × 9½-in.

No. 73 Netley Griller & Stand { Height: 27-in. Width: 15½-in. Depth: 14-in. outside.
„ 9½-in. „ 13½-in. „ 10⅛-in. inside Griller.

The 'Standard' Gas Heated Steam Radiator.

An Enamelled Vaporizer is fitted to each Radiator underneath the burner.

Weight of 6-section Radiator complete.

	c.	q.	lbs.
38-in. Size -	1	3	2
32-in. „ -	1	1	27
26-in. „ -	1	1	4

Each Radiator complete in itself.

Registered Design No. 531799.

Fitted with Automatic Gas Valve.

Only requires connecting up to gas pipe.

Base Plates extra.

Full instructions sent out with each Radiator.

PRICES ON APPLICATION. **Made in 3 sizes, as shown above.**

All Tubes are steam tested separately to a pressure of about 70-lbs. to the square inch. The pressure when in operation will be only about 2 lbs. to the square inch.

GAS COAL AND CANNEL CONTRACTORS.

MUNICH INCLINED CHAMBER FURNACES.

List of Munich Chamber Furnaces in Operation and under Construction:—

TOWNS.	No. of Settings.	Coal Capacity per 24 hours.	No. of Chambers.
Munich, Kierchstein	5	48·5 Tons	15
Munich, Moosach (1st Order)	6	117 ,,	18
Munich ,, (2nd Order)	6	117 ,,	18
Hamburg (1st Order)	10	195 ,,	30
Hamburg (2nd Order)	14	310 ,,	42
Berlin, Tegel	27	526 ,,	81
Paris, Genevilliers	20	272 ,,	60
Paris, La Villette	32	480 ,,	96

TOWNS.	No. of Settings.	Coal Capacity per 24 hours.	No. of Chambers.
Rome (1st order)	20	350 Tons	60
Rome (2nd order)	12	216 ,,	36
Leipsig (1st order)	8	156 ,,	24
Leipsig (2nd order)	8	156 ,,	24
Hanau	8	110 ,,	24
Regensburg	5	87 ,,	15

3140·5 TONS OF COAL PER DAY.

For Particulars and Tenders apply to:

THE COKE OVENS AND BY-PRODUCTS CO., LD.,

ST. STEPHENS HOUSE, WESTMINSTER, S.W.

Workmanship and Materials of the Highest Quality.

PECKETT'S LOCOMOTIVES.

Built to any Specification or Gauge.

PECKETT & SONS,
ATLAS LOCOMOTIVE WORKS, BRISTOL.

THE WIGAN COAL & IRON CO., LIMTD.,

Are the exclusive Owners of the well-known HAIGH HALL & KIRKLESS HALL GAS COAL COLLIERIES, Wigan, and of the Manton Steam and House Coal Collieries, Worksop, Notts, and supply the well-known Wigan Arley Mine Gas Coal, Gas Nuts, Gas Cannel, Cannel Nuts, House and Steam Coals, &c.

MIDLAND AND WEST OF ENGLAND DISTRICT OFFICE: *6, CORPORATION STREET, BIRMINGHAM—Sole Agent: A. C. SCRIVENER.*
Telegraphic Address: "WIGAN, BIRMINGHAM." Telephone: No. 200 CENTRAL.

LONDON DISTRICT OFFICE: *6, STRAND, LONDON—C. PARKER & SON, Sole Agents.* Telegraphic Address: "PARKER LONDON."

THE

GREAT POINT

FOR

GAS MANAGERS

TO-DAY

IS THE

MAKE PER TON.

WINSTANLEY & CO.'S

RECORDS

ARE HARD TO BEAT.

WINSTANLEY & CO.,
Murdoch Works,
KING'S NORTON.

Telegrams:
"WINSTANLEY, BIRMINGHAM."
Telephone: 88 KING'S NORTON.

JOSEPH EVANS & SONS, (WOLVERHAMPTON) LTD.

CULWELL WORKS, WOLVERHAMPTON.

Telegrams: "Evans, Wolverhampton." London Address: Salisbury House, London Wall, London, E.C. National Telephone: No. 39.

Please apply for Catalogue No. 8.

12,000 PUMPS IN STOCK AND PROGRESS.

TRADE MARK.

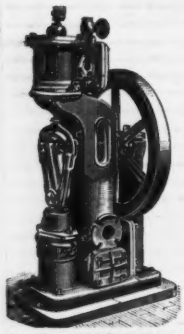


Fig. 705. "SINGLE RAM" STEAM-PUMP.

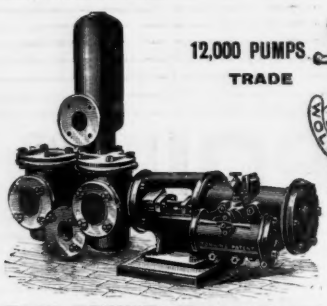


Fig. 898. "CORNISH" STEAM-PUMP FOR BOILER FEEDING, &c.

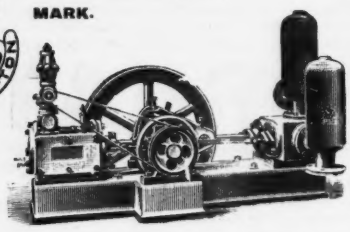


Fig. 685. "RELIABLE" STEAM PUMP FOR TAR AND THICK FLUIDS.

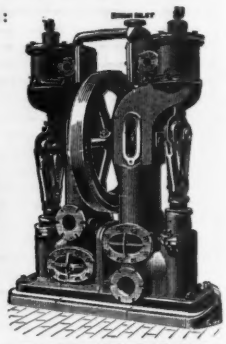


Fig. 712. "DOUBLE-RAM" STEAM-PUMP.

CLARKS "GASCOLITE"

(Registered Trade Mark.)

GREASE REMOVER

For quickly removing Grease from Gas Stoves.

Although only introduced Three Years it has broken down all prejudice long ago as it has proved beyond all doubt it is the FINEST PREPARATION on the market for this purpose.

Repeat orders from Gas Engineers are constantly coming from North, East, South, and West.

"THIS IS GASCOLITES REFERENCE."

Sold in ¼, ½, and 1 cwt. kegs.

Used either in Tanks or can be applied with a Brush.

Sole Proprietors:—

CLARKS LEAD & COLOUR WORKS CO.

Gas Company Specialists, Lead & Compo. Pipe Manufacturers, READING.

Makers of the brightest and most pliable compo. in England. Long Experience has taught us how to Produce Compo. and Lead Gas Pipe.

ESTABLISHED 1832.

". . . In a district where the soil is of such a nature that iron pipes are eaten away in a very short period . . . your tubes are not affected."

"Mannesmann Pipes . . . have three times the life of any others used under similar conditions here. . ."

"No signs of leakage though subject to much vibration."

"We . . . find that the cost works out 20 per cent. less than cast iron."

"The delivery of gas . . . is better."

The above are extracts from letters written by responsible Gas and Water Engineers in reference to

MANNESMANN WELDLESS STEEL TUBES

Illustrated Booklets and full copies of Testimonials on application.

THE

BRITISH MANNESMANN TUBE CO. LTD.,

SALISBURY HOUSE, LONDON WALL, LONDON, E.C.

Telephone: 4610, London Wall (Two lines). Works: Landore, South Wales.

Telegrams: "TUBULOUS, LONDON."

Branch Offices at BIRMINGHAM, NEWCASTLE-ON-TYNE, & MANCHESTER.

Agencies at Belfast, Cardiff, Glasgow, Middlesbrough, and Newport (Mon.).

Agents for New South Wales, Queensland, and Victoria: Messrs. NOYES BROS., SYDNEY, N.S.W.

HIGHEST AWARDS—LONDON, PARIS, COLOGNE, VIENNA, MELBOURNE, AND OTHERS.

—11 MEDALS.—

MANUFACTURERS OF TUBES AND FITTINGS OF EVERY DESCRIPTION.

WROUGHT-IRON OR STEEL MAINS UP TO 6 FEET DIAMETER FOR GAS, WATER, OIL, OR OTHER PURPOSES.

SCREWING TACKLE, BOILER MOUNTINGS, VALVES, COCKS, ETC.

LONDON: 108, Southwark Street. MANCHESTER: 33, King Street West. BIRMINGHAM: 14, Colmore Row. LEEDS: 6, Mark Lane, New Briggate.

TAYLOR'S SATURATORS AND LEADWORK.

Photo. showing Saturators, Acid Tanks, &c., on order delivered to the L. & Y. Railway Co., Bolton Station, May, 1911.

365

SATURATORS DELIVERED.

Repairs a Speciality.

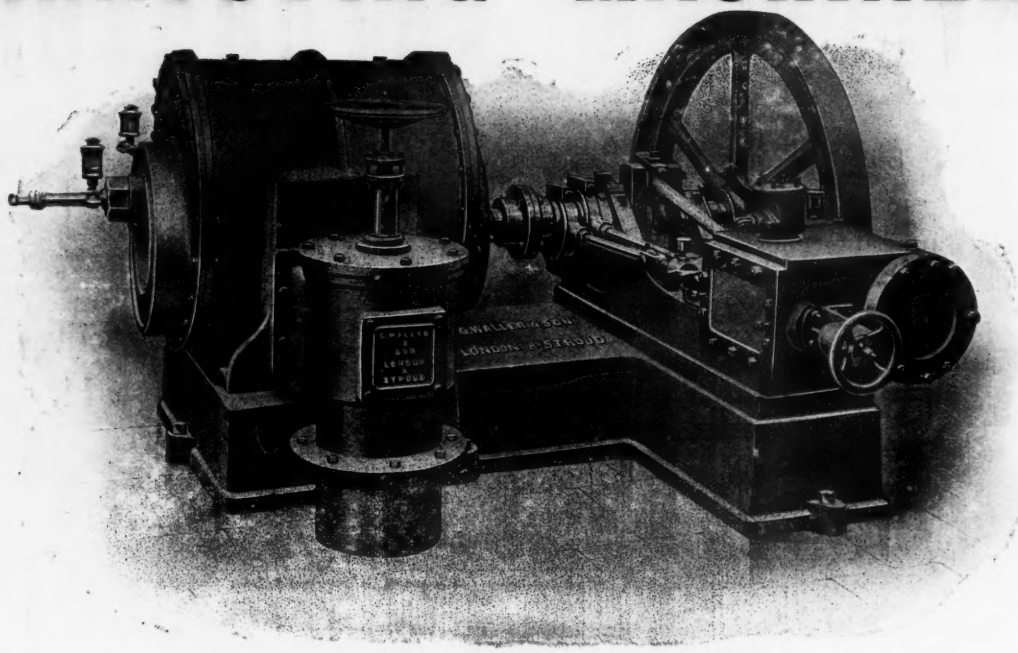
JOSEPH TAYLOR & CO.,

Central Plumbing Works, BOLTON.

Telegrams:
"SATURATORS BOLTON."

Telephones:
Nos. 848 and 119.

EXHAUSTING MACHINERY.



Waller's "E" type Exhauster Set for 80,000 cubic feet per hour.

WALLER'S PATENT

3 AND 4 BLADE EXHAUSTERS

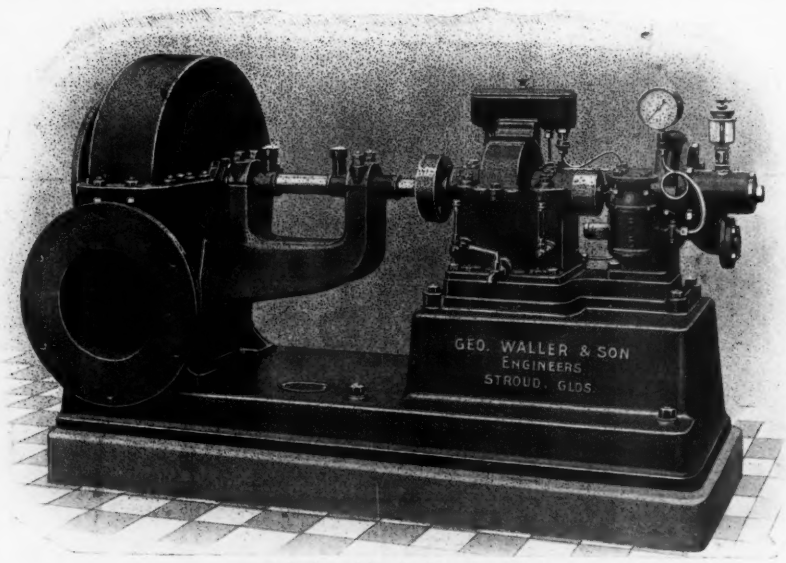
OVER 1400 SUPPLIED.

All Sizes from 500 to 500,000 Cubic Feet per hour. Maintain a steadier Gauge and require less Steam than any other Type.

GAS PRESSURE RAISING PLANTS

(GAS, STEAM, AND ELECTRIC DRIVEN)

FOR BOOSTING AND HIGH PRESSURE SERVICE.



Installation of Turbo-Boosting Plant.

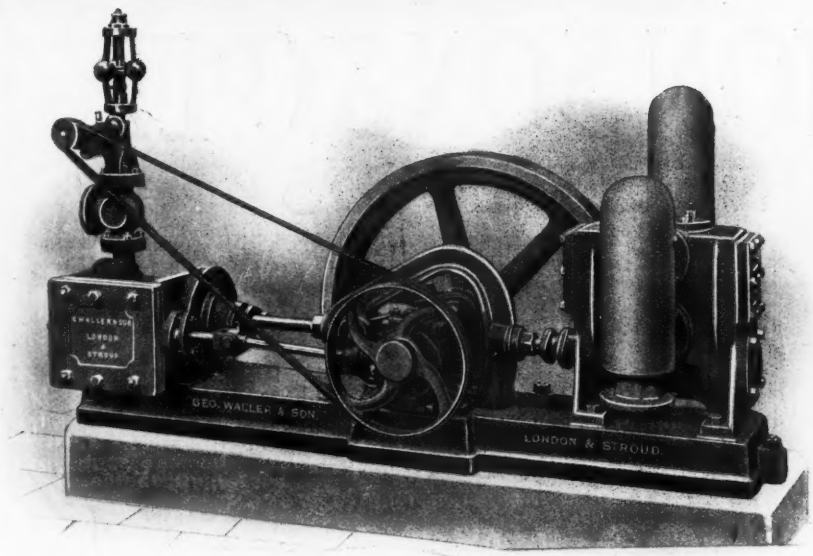
GEO. WALLER & SON,

PHŒNIX IRON WORKS, STROUD, GLOUCESTERSHIRE.

(D. M. NELSON & Co., 53, Waterloo Street, GLASGOW.—Agents for Scotland.)

PUMPS

For GAS-WORKS' PURPOSES,
Specially Designed for
TAR, LIQUOR, or WATER.



WALLER'S "PHŒNIX" DOUBLE ACTING STEAM PUMP
(Made in sizes from 3" × 2" × 3" to 12" × 9" × 18").

WALLER'S "COLUMN" TYPE PUMP
(Made in sizes from 1" × 3" to 4" × 6").

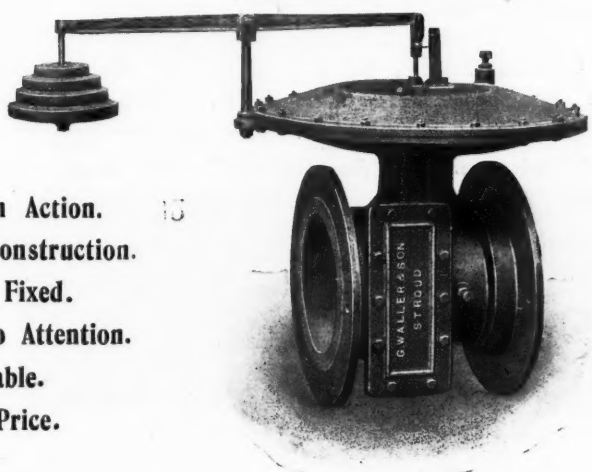
ALSO

"Cameron" type (single & double) Steam Pumps. Piston Valve Pumps with Reversing Gear for Tar.
Batteries of Pumps.
Gas Engine Driven Pumps. Electrically Driven Pumps. Belt Driven Pumps.

THE

"REESON" PATENT RETORT-HOUSE GOVERNOR.

(MADE IN ALL SIZES.)



Perfect in Action.
Simple in Construction.
Easily Fixed.
Requires No Attention.
Durable.
Low Price.

No Cylindrical Valves to get Clogged with Tar.

No Bells of Sheet Metal to Corrode.

No Water Tanks to Keep Filled.

This Governor is arranged for being fixed in the Foul Main in the usual position, or on a Bye-Pass, and can be adjusted immediately. All parts are at once accessible, and readily removed, if desired. Governors of this type have been in constant use for over Three Years, giving perfect Registers.

Write for Prices and Full Particulars—

Phœnix Iron Works,

GEO. WALLER & SON, STROUD, GLOUCESTERSHIRE.

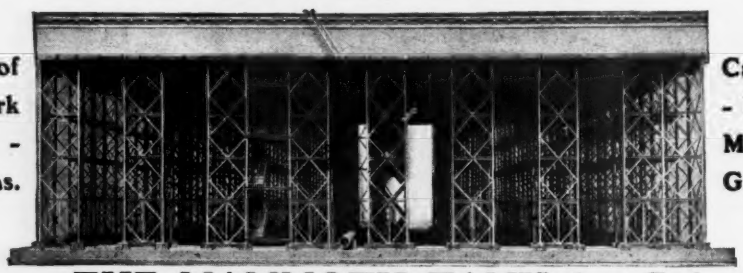
(D. M. NELSON & CO., 53, Waterloo Street, Glasgow—Agents for Scotland.)

CONTRACTORS TO HIS MAJESTY'S GOVERNMENT.

CLAYTON SON & Co LTD

HUNSLET, LEEDS

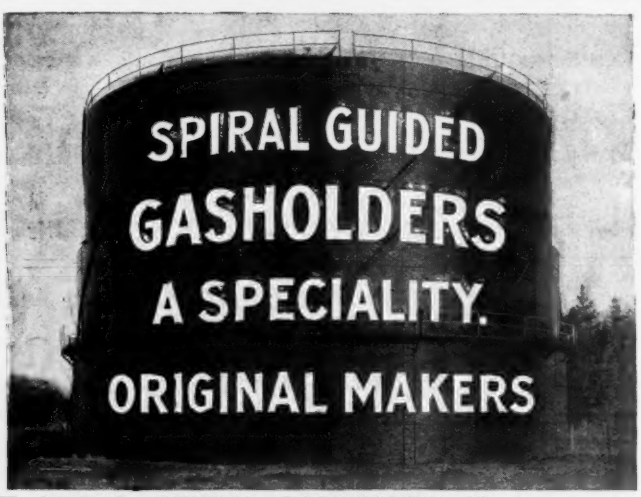
Weight of Steel Work - about - 7,000 tons.



Capacity - Nine - Million Gallons.

Makers of THE MAMMOTH TANK for Calcutta.

Purifiers.
Scrubbers.
Condensers.
Storage Tanks.

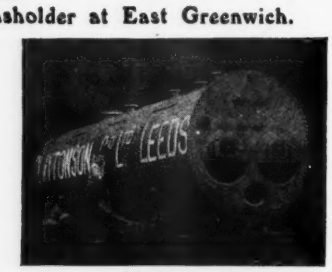


Structural Steelwork and Fittings for Retort Benches.

TWO-LIFT SPIRAL GUIDED GASHOLDER (Clayton and Pickering's Patent Guides) with **STEEL TANK**, being one of two Holders made and erected for the **NAPIER GAS CO. LTD.** (Hastings Works), **NEW ZEALAND.**

Makers of the 12 Million cubic feet Gasholder at East Greenwich.

Makers of
WELDED AND RIVETTED
- - STEEL MAINS FOR - -
- - WATER WORKS, &c. - -



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HIGH CLASS BOILERS OF
- - EVERY DESCRIPTION. - -
LARGE STOCK OF VERTICAL BOILERS ALWAYS ON HAND.

Telegrams: "GAS, LEEDS." London Office: 60, QUEEN VICTORIA ST., E.C.

ENGLAND, SCOTLAND, IRELAND, AND WALES.

Read the following reports made by Gas Engineers from all parts of the British Isles regarding

"LEAD WOOL"

(Registered Trade Mark)

for jointing mains for High or Low Pressure Gas Distribution:

INFORMAL MEETING OF SCOTTISH GAS MANAGERS.

5th April, 1911.

Annual Meeting in Glasgow.

The President (Mr. J. B. Scott, Cowdenbeath):—"The main is of Mannesmann Steel Tube, jointed in the ordinary way with molten lead joints . . . if he had to do the work again he would certainly prefer Lead Wool for the joints."

ANNUAL INFORMAL MEETING OF SCOTTISH GAS MANAGERS.

5th April, 1911.

An Open Discussion.

Mr. A. Yuill, Dundee:—"He advocated the use of Steel Tubes for high-pressure mains, and said that the results of experiments lead him to the conclusion that Lead Wool joints were infinitely stronger and better than molten lead joints."

SCOTTISH JUNIOR GAS ASSOCIATION.

7th January, 1911.

Eastern District.

Mr. A. Mitchell, Dundee:—"Before starting to lay the main, the compressor was completed, which enabled every joint to be thoroughly tested to 12 lbs. before being covered in. . . . The joints have two strands of yarn, the remainder being Lead Wool well caulked."

SOUTHERN DISTRICT GAS ASSOCIATION.

November, 1910.

Mr. H. O. Carr, Wandsworth:—"Certainly with Lead Wool they could get a joint equal to 10 lbs. pressure without any difficulty at all."

WAVERLEY ASSOCIATION OF GAS MANAGERS.

27th April, 1909.

Mr. W. Brown, Lasswade:—"During the summer there was laid about a mile of Mannesmann Tubes, 4 inches in diameter, with Lead Wool joints. As there was no connection to come off this, I can tell you it was a great advantage"

YORKSHIRE JUNIOR GAS ASSOCIATION.

19th January, 1909.

Mr. Butterfield, Silsden:—"Of the many things which have been invented in connection with main-laying, none in my opinion equals the use of Lead Wool as a jointing material."

SCOTTISH JUNIOR GAS ASSOCIATION.

17th November, 1908.

Mr. R. B. Waddell, Dunfermline:—"The pipe was a Mannesmann Steel Tube, jointed with Lead Wool and tested to 50 lbs."

24th October, 1908.

"Gas World"—"Current Topics":—"Referring to cast-iron mains, we are glad Mr. Hole mentioned, as a matter of interest, the rubber gasket joints which have been used with remarkable success in France and also in America. Their durability is contrary to expectation, but the result appears to be sufficiently established for us to favour the introduction of that type of joint in this country, were it not for the rapid progress of Lead Wool as a satisfactory competitor against the old cast lead joint."

MIDLAND ASSOCIATION OF GAS MANAGERS.

22nd October, 1908.

"High-Pressure Distribution.'

Remarks by Mr. W. C. Jones, Brierley Hill:—"Mr. Webb said that probably Lead Wool joints would give good results, and he (Mr. Jones) thought they would. As he told the members last October, he was then laying some 8-inch Mannesmann Pipes with Lead Wool joints, and the main he laid at the time was in ground that had been subject to severe disturbance. The surface of the ground had since then sunk over 12 feet, but he had only had to repair or set up something like seven joints during the whole of the time—these pipes being jointed by Lead Wool. If they would stand this sort of treatment they would stand any internal pressure. This was why he thought that probably Lead Wool might be a jointing material that would stand the higher pressures better than cast lead joints. Mr. Helps said last year that he had found cast lead joints were not satisfactory, and he (Mr. Jones) should have no hesitation in using Lead Wool joints, and the thin steel mains of the Mannesmann Company."

YORKSHIRE JUNIOR GAS ASSOCIATION.

20th October, 1908.

Mr. Hole, Leeds:—"He had no doubt that Lead Wool would give stronger joints than cast lead rings, and he had recently jointed a 20-inch main with it, and maintained a pressure of 35 lbs. for 14 hours without any leakage."

NORTH BRITISH ASSOCIATION OF GAS MANAGERS.

23rd September, 1908.

"High-Pressure Distribution"

Mr. A. Waddell, Dunfermline:—"He had adopted Lead Wool joints and had tested them to 50 lbs. pressure, and had not had any difficulty whatever with them."

IRISH ASSOCIATION OF GAS MANAGERS.

11th August, 1908.

"The Distribution Department."

Mr. J. Brodie, Lisburn:—"I am of opinion that these tubes made with the Parkinson Patent Joint and stayed with Lead Wool will prove to be one of the greatest aids in the diminution of leakage."

WALES AND MONMOUTH DISTRICT INSTITUTION OF GAS ENGINEERS AND MANAGERS.

6th May, 1908.

"High Pressure Incandescent Gas."

Mr. A. J. Ward, Cardiff:—"The joints were made with Lead Wool and his opinion was that this was very much better to withstand heavy strains and pressures. He had tested some of the joints up to 200 lbs. per square inch, and had also put a heavy load on the centre of the joint, and suspended the pipe at either end, and the joint withstood the test without showing the slightest leak. With a cast-iron main he was afraid that this would not be the case. Again using the Lead Wool they were able to secure a far greater density of the lead in the joint, because immediately they got a turn round it they commenced caulking and repeated this each turn."

SOUTHERN DISTRICT GAS ASSOCIATION.

12th March, 1908.

Mr. Norton H. Humphrys, Salisbury:—"For driving the socket joints of steel tubes we have a very decided preference for Lead Wool."

Have your next main jointed with "LEAD WOOL," with which you can make STRONGER JOINTS AT LESS COST than with run lead.

Send particulars of mains proposed to be laid, when full details as to costs will be given immediately by—

THE LEAD WOOL COMPANY, LIMITED, SNODLAND, KENT.

Telephone: No. 199 SNODLAND. **Telegrams: "STRENGTH, SNODLAND."**

IN A PROGRESSIVE INDUSTRY CHANGE IS INEVITABLE.

A TRIUMPHANT FACT.

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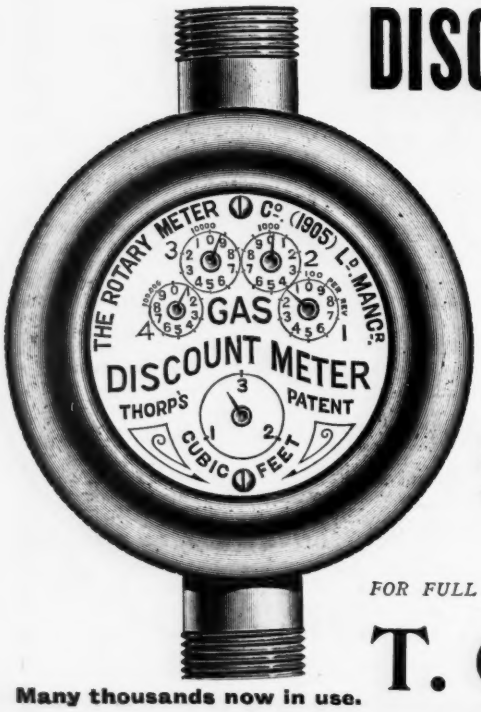
A PLEASING FACT.

LIGHT (from gas) costs 50 per cent. less than in the past, due to Baron Auer von Welsbach's inventions.

HEAT has not been reduced in price. No improvement has been made on the burner introduced by Bunsen.

SLOT METERS, originally pioneered by the Introducers of the Discount Meter (Messrs. Marsh and Thorp), have been the most prolific cause of increased use of Coal Gas.

DISCOUNT METERS. The increased use of these, and an allowance of a Rebate on Gas used for Fires and Stoves, will do more for the Gas Industry than any invention of the decade.



Many thousands now in use.

DISCOUNT OR CHECK METERS.

With One of these Attached to the Gas Range or Fire,

The User may be kept informed as to the Gas used per day, week, or month, or per operation, and the consumer will realize the trifling cost of Heating and Cooking by Gas.

	No. 1.	No. 2.	No. 3.
PRICE - -	15/6	15/6	16/6
With Unions	16/6	16/6	17/6
To Measure	5 to 15 c. ft. per hour.	10 to 30 c. ft. per hour.	10 to 50 c. ft per hour.

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LEEDS.

PHOTO. OF AN INCLINED RETORT BENCH ERECTED BY US.

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THE VERTICAL GAS RETORT SYNDICATE, Ltd.,
For all BRICKWORK and CONVEYING PLANT for the
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ELEVATORS, CONVEYORS,
STORAGE PLANTS,
FOR COAL, COKE, LIME, OXIDE, &c.

ROOFS, STORAGE BUNKERS,
COALBREAKERS, TELPHERS,
STEEL STRUCTURAL WORK, &c.

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WROUGHT IRON AND STEEL TUBES

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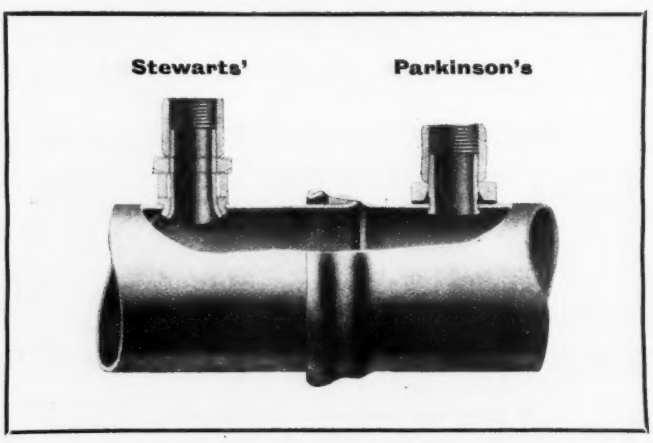
LAPWELDED, BUTTWELDED, WELDLESS, & LOCK BAR Processes.

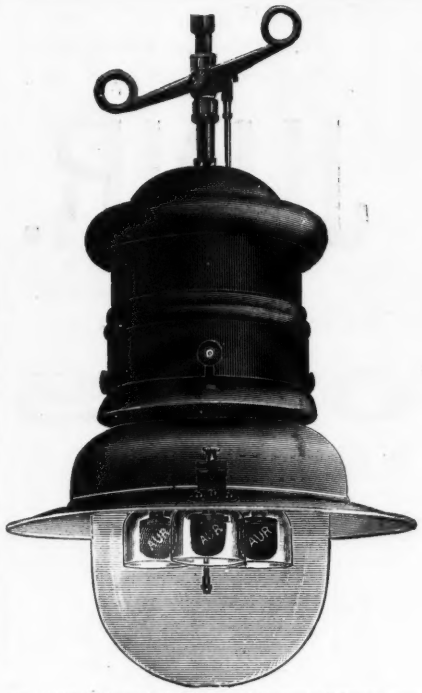
STEEL GAS PIPES WITH STEWARTS' INSERTED JOINT MADE IN ALL SIZES UP TO 48" DIA. IN ANY LENGTHS UP TO 40 FEET, AND FOR THE HIGHEST WORKING PRESSURES.

Part of an order for 35 miles of Steel Pipes, with Stewarts' Inserted Joint.

OUR STEEL PIPES IN THE SMALLER SIZES CAN BE BENT ON THE GROUND TO SUIT REQUIREMENTS, OR SUPPLIED BENT UP TO 24" DIA. AND WITH WELDED OR RIVETED BRANCHES.



Standard Branch Service Connections.



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¶ Welsbach Mantles are a perfect combination.

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The Welsbach Mantles are "C," "CX," and "Plaissetty," Price 4½d. each, 4/3 per dozen. Welsbach Inverted Mantles, 4½d each, 4/3 per dozen.

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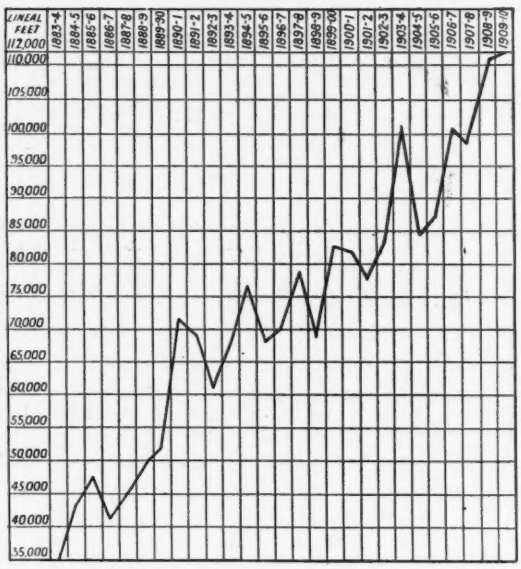
at a slight advance in price. Over 90,000 feet already booked for this season's delivery; we still guarantee that this Retort will excel all others in refractoriness and durability.



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FURTHER UP-TO-DATE Machinery Installed to make these "SPECIAL QUALITY" RETORTS.

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Including Special Tiles for Generator and Regenerator Retort Settings.

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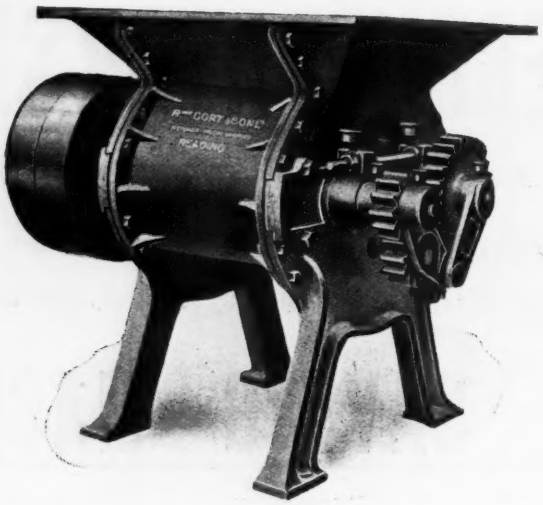

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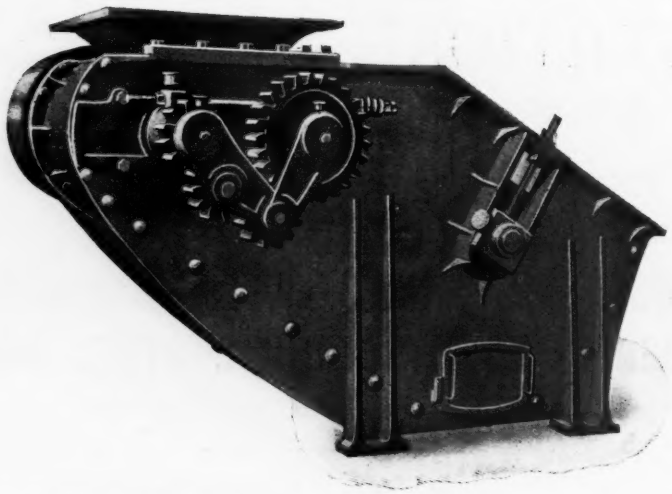

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Gas Purifying Material.

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Purifier changes are less by over one-half when using "LUX" as compared with Bog Ore, and it requires considerably less turning than Bog Ore for revivification.

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"LUX" is easily charged with Sulphur 55/60%. Once used, always used, is the verdict of many Gas Engineers in this country who have tried it during the past 2½ years.

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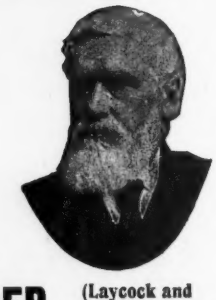

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BALL WASHER SCRUBBER (Laycock and Clapham's Patent).

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